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Volume 17 Number 23

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December 15, 1963

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Volume 17, Number 23, December 15, 1963

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Volume 17, Number 23 December 15, 1963

NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

38583 (CU(PNPL)-227) PROCEEDINGS [OF] CONFERENCE ON THE UTILIZATION OF MULTIPARAMETER ANALYZERS IN NUCLEAR PHYSICS [HELD AT] GROSSINGER, NEW YORK, NOVEMBER 12-15, 1962. L. J. Lidofsky, ed. (Columbia Univ., New York). 185p. (NYO-10595)

Separate abstracts were prepared for 29 of the 36 papers; seven papers were previously abstracted in NSA. (D.C.W.)

38584 (CU(PNPL)-227(p.9-10)) ECONOMIC ASPECTS OF MULTIPARAMETER ANALYZERS. George A. Kolstad (Atomic Energy Commission, Washington, D. C.).

Development of computer analysis systems is briefly outlined; and accomplishments, activities, and trends in automatic data analysis are indicated. The need for standardizing some systems or components so that industry can supply them is noted. (D.C.W.)

38585 (CU(PNPL)-227(p.11-21)) A REVIEW OF DATA ANALYSIS SYSTEMS FOR NUCLEAR AND HIGH ENERGY PHYSICS IN AEC LABORATORIES. W. F. Miller (Argonne National Lab., Ill.) and Harry W. Fulbright (Rochester, N. Y. Univ.).

The data analysis systems for nuclear physics and high energy systems now in use or in the planning stage in several AEC laboratories are described. Costs and advantages of the systems are examined, and trends are pointed out. (auth)

38586 (CU(PNPL)-227(p.22-5)) LOW ENERGY NUCLEAR PHYSICS APPLICATIONS OF MULTIPARAMETER ANALYZERS. Leon J. Lidofsky (Columbia Univ., New York).

The rise in interest in multiparameter analyzers is discussed, and examples of their use in experiments in fission neutron capture, gamma-ray sepctroscopy, and beta-ray spectroscopy are given. It is concluded that the data-handling problem will be emphasized by the use of these analyzers and computer compatibility is imperative. (auth)

38587 (CU(PNPL)-227(p.25-8)) HIGH ENERGY PHYSICS APPLICATIONS OF MULTIPARAMETER ANALYZERS. Irwin Pless (Massachusetts Inst. of Tech., Cambridge).

Multiparameter analyzer applications to several high energy physics experiments are discussed. A counter experiment involving diffraction scattering on protons is described. In this experiment an on-line computer is used to reduce the experimental parameters to differential cross sections in real time. Photographic recording of experiments using bubble chambers and spark chambers is also considered. Several on-line computer systems for the scanning and analysis of photographs (HPD, PEPR, and SMP) are described. (auth)

38588 (CU(PNPL)-227(p.35-48)) MULTIPARAMETER ANALYSIS IN ACCELERATOR STUDIES IN NUCLEAR PHYSICS. D. A. Bromley (Yale Univ., New Haven); C. D. Goodman, and G. D. O'Kelley (Oak Ridge National Lab., Tenn.).

The Yale-ORNL 20,000-channel analyzer and a number of the considerations that conditioned the specifications for this instrument are described. A number of selected nuclear reaction studies are presented to illustrate the utilization of the analyzer and to emphasize a number of the salient advantages inherent in the design. The examples are restricted to those associated with an accelerator as used in nuclear physics research. (auth)

38589 (CU(PNPL)-227(p.49-56)) THE ROLE OF MULTIPARAMETER PULSE-HEIGHT ANALYZERS IN RADIOACTIVITY STUDIES. G. D. O'Kelley, C. D. Goodman (Oak Ridge National Lab., Tenn); and D. A. Bromley (Yale Univ., New Haven).

Design considerations are given for a multiparameter pulse-height analyser to be used in studies of radioactive decay schemes. Recommended memory size is at least 200×100 channels with a capacity of $\geq 10^5$ per channel; average dead time should be ≤ 400 μsec. A display of the entire memory should be available, and the capability for storing singles spectra should also be provided. A 20,000-channel analyzer that meets these requirements is described. Some practical applications of the instrument are discussed, including storage of true and random coincidences; gamma-gamma, beta-gamma, and beta-neutron coincidence spectrometry; angular correlations; the use of sum spectra; and storage of one-parameter spectra as a function of time in a large memory. (auth)

38590 (CU(PNPL)-227(p.56-8)) AN MPA SYSTEM THAT IS FLEXIBLE, RELIABLE, AND FAST. Edwin Norbeck (Iowa. State Univ., Iowa City).

Design and operation of the two-parameter analysis system are described. The system, built around a CDC 160 computer, has performed successfully. Expansion to a CDC 160-A computer and two tape units will allow very fast three parameter (10^9 channels) analysis. The modified system is discussed. (D.C.W.)

38591 (CU(PNPL)-227(p.69-73)) THE USE OF 65,000-CHANNEL MAGNETIC TAPE SYSTEMS IN NUCLEAR DATA MEASUREMENTS AT A.E.R.E., HARWELL, ENGLAND. Frank H. Wells, J. G. Page, and A. Lewis (United Kingdom Atomic Energy Authority. Research Group.

Atomic Energy Research Establishment, Harwell, Berks, England).

A 1-in. 16-track digital tape system forms the basis of the 65,000-channel MPA units in use at Harwell. These are used in a variety of single-parameter and multiparameter experiments. The data are totalized in blocks using 1024-channel analyzers. The reliability of the systems is discussed. Improvements under development include variable-speed tape drive to assure maximum packing density, faster ADCs, and monitoring systems. Real-time totalizing systems with capacities to 20,000 channels are under consideration. (auth)

38592 (CU(PNPL)-227(p.74-6)) PUNCH TAPE STORAGE FOR LOW COUNT RATE EXPERIMENTS. J. H. Neiler (Oak Ridge National Lab., Tenn.).

A three-parameter analyzer that serially records on punched paper tape is described. The uses of the analyzer are illustrated by a description of a two-parameter fission study. The subsequent data-processing procedure is outlined. (auth)

38593 (CU(PNPL)-227(p.77)) THREE-PARAMETER ANALYZER FOR FISSION STUDIES. Edward Melkonian (Columbia Univ., New York).

A three-parameter analyzer using paper tape storage is described, and its application to certain proposed experiments in thermal neutron-induced fission is discussed. (auth)

38594 (CU(PNPL)-227(p.79-83)) ANALOG-TO-DIGITAL CONVERTERS FOR PULSE-HEIGHT ANALYSIS. R. L. Chase (Brookhaven National Lab., Upton, N. Y.). (BNL-6522)

The important characteristics (discussed) for analog-to-digital converters for pulse-height analysis include high resolution, integral and differential linearity, large dynamic range, and minimum dead-time. Several systems are considered, and their success in achieving these characteristics is discussed. (auth)

38595 (CU(PNPL)-227(p.84-9)) STORAGE SYSTEMS. Norman R. Scott (Michigan. Univ., Ann Arbor).

The characteristics of computer memory devices and the organization of these devices into memory systems are discussed. The status of miniaturization, cryogenic memories, and thin film magnetics is examined. Emphasis is placed upon the memory organization. In addition to the standard fixed-address storage, other types of memory organization (buffer storage, list storage, associative storage, storage hierarchies) are considered. (auth)

38596 (CU(PNPL)-227(p.90-4)) READOUTS FOR MULTIPARAMETER ANALYZERS. C. F. Beckett, J. D. Gallagher, and R. B. Glascock (Los Alamos Scientific Lab., N. Mex.).

The existing multiparameter analyzers at the Los Alamos Scientific Laboratory are described with emphasis on the data-recording portion of the analyzers. The format and other requirements for computer compatibility are discussed to show what may be required of future recording systems. (auth)

38597 (CU(PNPL)-227(p.99-101)) SOME CONSIDERATIONS IN THE THREE-DIMENSIONAL PRESENTATION OF INFORMATION. Herschel Leibowitz (Pennsylvania State Univ., University Park).

The three-dimensional presentation of information is examined from the viewpoint of experimental psychology. Three methods simulating the sensation of depth are described: isometric projection, stereoscopic projection, and volumetric displays. (auth)

38598 (CU(PNPL)-227(p.102-3)) VOLUMETRIC DISPLAY CONCEPTS FOR MULTIPARAMETER ANALYSIS. Raymond C. Bassett (ITT Federal Labs. Div. of International Telephone and Telegraph Corp., Nutley, N. J.).

Problems relating to volumetric displays are considered, with emphasis placed upon the human factors aspect. A method of obtaining a volumetric display is presented; the system utilizes a rotating passive optical-projection screen with the information developed on a cathode ray tube. (auth)

38599 (CU(PNPL-227(p.112-13)) VISUAL AIDS USED AT LAWRENCE RADIATION LABORATORY. George Michael (California. Univ., Livermore. Lawrence Radiation Lab.).

Three types of useful visual aids are discussed: CRT displays in color, stereoscopic projections, and motion picture sequences. Examples of the use of a computer in generating these are described. (auth)

38600 (CU(PNPL)-227(p.120-31)) ANALYSIS OF COMPLEX GAMMA-RAY SPECTRA. R. L. Heath (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho).

Methods of analysis of complex gamma-ray spectra, including graphical analysis by subtraction, linear least-squares method, and the general incremental method, are critically examined. Since the general problem is extremely difficult, a modular approach to the programing has been followed. The four important units of the general analysis program —detector-response program, coincidence-sum spectrum program, photopeak-fitting program, and gain-shift program —are discussed in detail. (auth)

38601 (CU(PNPL)-227(p.137-8)) ANALOG COMPUTER APPLICATIONS IN MULTIPARAMETER ANALYSIS. Frank H. Wells (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England).

The use of an analog computer to reduce the output of a three-parameter (energy, rate of energy loss, time) data-acquisition system with about 10^7 different possible combinations to a more meaningful two-parameter (nature of particle, energy) form is described. The final form of the data can be totalized in a system with a 2500 (five kinds of particles times 500 energy channels) work memory. (auth)

38602 (CU(PNPL)-227(p.139-41)) EXAMINING AND PROCESSING MULTIPARAMETER DATA FROM THE ORNL-YALE ANALYZERS. C. D. Goodman, G. D. O'Kelley (Oak Ridge National Lab., Tenn.); and D. A. Bromley (Yale Univ., New Haven).

The data-processing system for use with the ORNL-YALE analyzers is described. At present the contents of the analyzer memory will be read out selectively on tape and transported to a computer for analysis. The possibility for a further direct computer link is discussed. (auth)

38603 (CU(PNPL)-227(p.149-54)) A STORED-PROGRAM COMPUTER AS A MULTIPARAMETER RADIATION ANALYZER. J. V. Kane (Bell Telephone Labs., Inc., Murray Hill, N. J.) and R. J. Spinrad (Brookhaven National Lab., Upton, N. Y.). (BNL-6534)

The use of a stored-program computer as a multichannel radiation analyzer is described. Data recording and display, system organization, programs, and advantages and limitations are discussed. (D.C.W.)

38604 (CU(PNPL)-227(p.155-9)) MULTIPLE ACCESS TO AN INTEGRATED PULSE-ANALYZING AND COM-

PUTER SYSTEM. J. Leng (Atomic Energy of Canada Ltd., Chalk River, Ont.).

Computer-analyzer systems for accessing experimental results and for handling the results of several experiments concurrently are discussed. A computer-based analyzer and an integrated computer-analyzer system are considered. (D.C.W.)

38605 (CU(PNPL)-227(p.160-2)) AN INTEGRATED DATA COLLECTION AND TREATMENT SYSTEM FOR A VAN DE GRAAFF ACCELERATOR. Philip Malmberg (Naval Research Lab., Washington, D. C.).

A study of an idealized integrated system for the collection and treatment of data of the type produced at a Van de Graaff accelerator is summarized. (auth)

38606 (CU(PNPL)-227(p.162-5)) ON-LINE COMPUTER UTILIZATION IN NUCLEAR REACTION STUDIES. D. A. Bromley (Yale Univ., New Haven).

The use of an on-line computer to control data acquisition and the primary radiation source, in addition to more common data analysis, offers many advantages in nuclear reaction studies. These are illustrated by two examples developed for possible use with a large electrostatic accelerator in the study of reaction excitation functions and angular distributions, respectively. (auth)

38607 (CU(PNPL)-227(p.167-70)) A SPARK CHAMBER AUTOMATIC SCANNING SYSTEM. Martin Deutsch (Massachusetts Inst. of Tech., Cambridge).

The bases for the design of a particular spark chamber automatic scanning system are discussed. Descriptions of the mechanical equipment and the operation of the computer program are given. The system scans and measures approximately one picture per second with a present reliability of >98%. (auth)

38608 (CU(PNPL)-227(p.171-2)) SONIC SPARK CHAMBER MEASUREMENT OF THE BETA SPECTRUM FROM MU DECAY. Allan M. Sachs (Columbia Univ., New York).

An experiment designed to measure the momentum spectrum of the electrons in mu-decay is described. Each decay electron passes through a hodoscope, a magnetic field, and a second hodoscope. The hodoscopes consist of sonic spark chambers with several transducers per gap. The output of the transducers is digitalized using individual units and their outputs are buffered in a small computer and stored on magnetic tape. The tape is transferred later to a large computer where the momentum corresponding to each event is calculated. (auth)

38609 (CU(PNPL)-227(p.172-3)) INSTRUMENTATION FOR A SONIC SPARK CHAMBER. Frank H. Wells (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England).

A six-element sonic spark chamber hodoscope using several transducers per chamber is to be used at Harwell to indicate the directions of products following a nuclear reaction. Fast temporary memory allows the total information from an event to be stored. This information is transferred on a time-sharing basis to an on-line computer, and an analysis of the event is completed in a time that is short compared to the recharging time of the spark chamber (10 msec). (auth)

38610 (CU(PNPL)-227(p.175-8)) FUTURE NEEDS FOR MULTIPARAMETER ANALYZER SYSTEMS. (Columbia Univ., New York).

Several specific needs for multiparameter analyzer systems and experiments are discussed. Among these are included short dead-time analog-to-digital converters, stable detectors, and/or commercially available detector-stabilizer systems, modular construction techniques to avoid obsolescence, and better computer programing systems to alleviate the data-reduction and analysis problems. (auth)

38611 (CU(PNPL)-227(p.179-81)) SOME APPLICATIONS OF INFORMATION THEORY TO DATA HANDLING. Martin Graham (Rice Univ., Houston, Tex.).

Some applications of information theory to data-handling problems are considered. The importance of condensing the information before presenting it to the experimenter is emphasized. The use of computer technique to perform this condensation may relieve the necessity for large memories used primarily to generate real-time display. (auth)

38612 (CU(PNPL)-227(p.181-2)) SOME THOUGHTS FOR THE FUTURE. George A. Kolstad (Atomic Energy Commission, Washington, D. C.).

Areas in which there is a need for future multiparameter analyzer-computer system improvement are briefly reviewed. The economic aspects of the problem and possible approaches to the problems are discussed. (auth)

38613 (DASA-618) ELECTROMAGNETIC PULSE BIBLIOGRAPHY. Charles A. Blank, comp. (Defense Atomic Support Agency, Washington, D. C.). Jan. 17, 1963. 56p. (AD-296777)

One hundred forty-nine references to reports dealing with the electromagnetic pulse produced by nuclear explosions are compiled. Procedures for procuring the reports are included. (D.C.W.)

38614 (HW-68600-30) PLUTONIUM ABSTRACTS. Volume 3, Number 8. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1, 1963. Contract AT(45-1)-1350. 10p.

Twenty references on studies on Pu in biology, chemistry, metallurgy and ceramics, physics, and reactor technology are given to reports and U. S. and foreign journals published from Feb. 1962 through August 1963. Abstracts are provided for each reference. (P.C.H.)

38615 (HW-68600-31) PLUTONIUM ABSTRACTS. Volume 3, Number 9. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1, 1963. Contract AT(45-1)-1350. 11p.

A total of 28 references in abstracted form is given which relate to new developments in plutonium technology. The references are arranged according to chemistry, metallurgy and ceramics, physics, and reactor technology. (D.L.C.)

38616 (MDL-Q2) CONSOLIDATED QUARTERLY REPORT [ON RESEARCH ACTIVITY], JULY 1, 1962 TO SEPTEMBER 30, 1962. (Utah. Univ., Salt Lake City). Sept. 30, 1962. Contracts Nonr 1288(05); AF04(647)-745; and AF33(657)-8677. 63p. (AD-291666)

Research progress on the extension of the useful frequency spectrum into the range from microwave to optical frequencies and on the improvement of existing devices and frequencies in the microwave spectrum is reported. Electron beam devices, solid state devices, and plasmas were studied. (D.C.W.)

38617 (NP-13128) ANNUAL REPORT, 1961. (Turkey. Atomic Energy Commission, Ankara). 33p.

Activities of the Turkish Atomic Energy Commission

during 1961 are summarized. Training programs and uses of radioisotopes in agriculture and medicine are described. Construction of the Çekmece Reactor was completed in Sept. 1961. Complete and proposed atomic research facilities are discussed. (C.H.)

38618 (NP-13150) NRL QUARTERLY ON NUCLEAR SCIENCE AND TECHNOLOGY. Progress Report for the Period January–March 1963. (Naval Research Lab., Washington, D. C.). Apr. 1, 1963. 34p.

Separate abstracts were prepared for the eight papers included. (D.C.W.)

38619 (NP-13150(p.1-3)) CROSS SECTIONS OF THE $Ne^{20}(t,p)Ne^{22}$ REACTION. L. Cohen and L. M. Cameron (Naval Research Lab., Washington, D. C.).

The protons emitted in the reaction were observed, particularly those going to the ground and first excited states of Ne^{22}. Proton groups due to other reactions also appear in these spectra. Differential and total cross sections were obtained for the two proton groups of concern. The differential cross sections indicate that, primarily, direct reaction processes are occurring. The total cross section for the ground state group agrees with Holmgren's values. (D.C.W.)

38620 (NP-13150(p.4-9)) GAMMA-RAY SPECTROMETER DESIGNED TO REDUCE THE EFFECTS OF COMPTON SCATTERING. R. E. Larson and C. M. Gordon (Naval Research Lab., Washington, D. C.).

The principal detector is surrounded by a large tank of liquid scintillator. A photon scattered by the principal detector into the scintillator produces a signal that is used in anticoincidence to reject the signal from the principal detector. Gamma spectra from point sources and from filter paper samples under neutron activation analysis, with and without anticoincidence, show the effectiveness of the system. Comparison of the spectra with and without anticoincidence aids in identifying the radioactive isotopes present by resolving the gamma rays. (D.C.W.)

38621 (NP-13150(p.10-18)) CROSS SECTION, BREAKUP MODES AND PHOTON INTERACTION FOR THE $C^{12}(\gamma,3\alpha)$ REACTION BELOW 21.5 Mev. M. Elaine Toms (Naval Research Lab., Washington, D. C.).

The cross sections were measured by exposing two pairs of Ilford E-1 nuclear emulsions to a 21.5-Mev bremsstrahlung beam filtered by aluminum and by graphite. The results show that above 14.2 Mev breakup is primarily by emission of one alpha particle leaving a Be^8 nucleus in a 3.0 Mev excited state. Below 12.2 Mev breakup mainly occurs through the Be^8 ground state. For 12.2–14.2 Mev breakup through the excited and ground states occurs almost equally. The modes of photon interaction also vary with the excitation energy. (D.C.W.)

38622 (NP-13150(p.19-21)) EMPIRICAL RELATIONSHIP BETWEEN BUILDUP FACTORS OF OBLIQUELY AND NORMALLY INCIDENT GAMMA RAYS. A. G. Pieper and L. A. Beach (Naval Research Lab., Washington, D. C.).

A comparison of buildup factors calculated for gamma rays normally and obliquely incident on several slab shields showed that the two could be related by a simple expression. The nature, range, and validity of this relation are demonstrated by calculations for lead slabs. (D.C.W.)

38623 (NP-13150(p.22-5)) THE FILAMENT BEAM PROBLEM CONSIDERED IN TERMS OF A SECTIONALLY HOMOGENEOUS PHASE FLUID (THE WATER-BAG MODEL). J. B. Ehrman (Naval Research Lab., Washington, D. C.).

An extension of dePackh's water-bag model from a one-dimensional sheet beam to a two-dimensional filament beam is described. Only time-independent solutions are considered. (auth)

38624 (NP-13150(p.26-7)) EFFECT OF A LONG COLLIMATING TUBE ON A WATER-BAG SHEET BEAM. D. C. dePackh (Naval Research Lab., Washington, D. C.).

A long collimator would seemingly lead to another water-bag beam of smaller diameter and of different parameters. A relation for the change in the ratio of central plasma frequency to betatron plasma frequency squared resulting from the collimation is derived. Also, the time for which the collimator is needed is calculated. (D.C.W.)

38625 (NP-13150(p.28-30)) DENSITY MATCHING IN SCL BEAMS. D. C. dePackh (Naval Research Lab., Washington, D. C.).

Approximate relations are derived for determining the parameters for matching beam densities in different parts of a space-charge-limited-beam system. The use of the graphical interpretation of the equations is illustrated. (D.C.W.)

38626 (NP-13150(p.31-2)) THE RAYLEIGH-CARSON THEOREM FOR MAGNETO-ACTIVE PLASMA. W. R. Faust (Naval Research Lab., Washington, D. C.).

The field equations describing the propagation of an electromagnetic signal in an uncharged magneto-active plasma are used to derive current density-field relations for the situation in which there are two different distributions of applied fields. (D.C.W.)

38627 (TID-3719) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress During the Period, August-September 1963. (Division of Technical Information Extension, AEC). 16p.

A total of 99 bibliographies are listed. A subject and author index is included. (D.L.C.)

38628 MANAGEMENT — SIMULATION. R. Augier de Cremiers. Energie Nucl., 5: 311-17(June 1963). (In French)

The use of punch cards in the financial and administrative management of the Marcoule Center is briefly indicated. Their use in the fuel-loading program to assure homogenization of fuel irradiation is discussed in some detail. (J.S.R.)

38629 MAGNETOTELLURIC AND VERY LOW FREQUENCY SIGNATURES FROM SMALL HIGH-ALTITUDE NUCLEAR EXPLOSIONS. R. A. Santirocco and D. G. Parker (General Dynamics/Electronics, Rochester, N. Y.). Nature, 199: 1273-5(Sept. 28, 1963).

A preliminary account of the magnetotelluric and very-low-frequency signatures associated with the U. S. high-altitude nuclear detonations of Oct. 20 and 26 and Nov. 1 and 4, 1962, observed near Rochester, New York, is presented. Generally weak and variable signatures were displayed. The prompt magnetotelluric signatures were highly variable. On Oct. 26 a delayed magnetotelluric signature occurred 2.5 sec after detonation. A magnetotelluric signature component delayed by 4 to 7 sec occurred consistently for all four tests. Prompt broadband VLF pulses were observed only on Oct. 20 and Nov. 1. Besides the neutron-decay phase delays there was weak evidence of a transient phase excursion on the VLF signal propagated from a station near Seattle, Washington, occurring about 12 sec after detonation of the last three tests. (M.C.G.)

38630 CHANGE, HOPE, AND THE BOMB. David E. Lilienthal. Princeton, N. J., Princeton University Press, 1963. 172p. $3.50.

The Stafford Little Lecture series given at Princeton University in February 1963 was used as the basis for this book. Topics covered include disarmament, the role of the atom in modern life, the place of scientists in society, and the role of the AEC. (M.C.G.)

BIOLOGY AND MEDICINE

General and Miscellaneous

38631 (TID-3913) A BIBLIOGRAPHY OF ARTICLES PERTINENT TO MARINE PRIMARY PRODUCTIVITY. Maxwell S. Doty (Hawaii. Univ., Honolulu. Hawaii Marine Lab.). [nd]. Contract [AT(04-3)-15]. 30p.

38632 (UCD-108) THE EFFECTS OF CONTINUAL Sr^{90} INGESTION DURING THE GROWTH PERIOD OF THE BEAGLE AND ITS RELATION TO Ra^{226} TOXICITY. (Cover carries title: LONG TERM EFFECTS OF STRONTIUM-90 ON THE BEAGLE). Annual Progress Report No. 6. A. C. Andersen (California. Univ., Davis. School of Veterinary Medicine). Aug. 1963. Contract AT(04-3)-472. 162p.

Separate abstracts have been prepared for fourteen papers included in the report. (H.M.G.)

38633 (UCD-108(p.1-9)) DOG CAGE CONSTRUCTION— RADIONUCLIDE TREATMENT FACILITY. A. C. Andersen and C. Potts (California. Univ., Davis. School of Veterinary Medicine).

Design and construction of cages to be used in the treatment of beagles with radionuclides was presented, with emphasis on the principal requirements of acceptable restraining environment, radiological safety precautions, ease of observing and handling the dogs, and low initial and maintenance costs. Experience gained during a trial period with smaller moveable cage units of fiber glass has resulted in the development of a stationary cage unit which has the advantages of permanence, durability, more economical utilization of building space, and considerably reduced construction and maintenance costs. (auth)

38634 (UCD-108(p.10-19)) KENNEL STATUS REPORT— CHANGES AND OBSERVATIONS IN A PRODUCING EXPERIMENTAL BEAGLE COLONY. D. H. McKelvie and J. W. Parcher (California. Univ., Davis. School of Veterinary Medicine).

Staff organization, established procedures for routine daily care, clinical observations and acceptable therapeutic measures, involved in the maintenance of a large, producing beagle colony for the conduct of the Sr^{90} feeding program, are reviewed briefly, with particular emphasis on extending the experience thus far gained into the expanding Sr^{90} and Ra^{226} programs, for which new facilities, both indoor and outdoor, are nearing completion. (auth)

38635 (UCD-108(p.20-6)) A METHOD FOR MAINTAINING AN OUTBRED BEAGLE COLONY. D. H. McKelvie (California. Univ., Davis. School of Veterinary Medicine).

Outbreeding in a beagle colony has been facilitated by replacing complex registered names with a simple coding system. A special assignment board, designed to give an overall view of the breeding program, has aided in the assignment of females to males in accordance with experimental design. (auth)

38636 (UCD-108(p.27-36)) OBSERVATIONS ON CAGE REARED BEAGLES MAINTAINED ON VARYING LEVELS OF Sr^{90} IN THE DIET. D. H. McKelvie and J. W. Parcher (California. Univ., Davis. School of Veterinary Medicine).

Accumulation of data on body weight changes, chemistry of blood and body fluids, skeletal development, etc., from beagles on a series of dietary Sr^{90} dose levels, as compared with controls on the regular diet, is proceeding in both indoor cage and outdoor pen environments. Transfer from cages to pens, at a suitable interval following the end of the Sr^{90} ingestion period, requires special preparation of the pens (cleaning, and replacing of gravel) and daily surveillance of the dogs for the first four weeks, in order to minimize the stress of transition. No clear cut evidence of dose-related effects can be cited at this early stage in the program. (auth)

38637 (UCD-108(p.37-44)) CONTINUOUS FEEDING OF Sr^{90} TO BEAGLES— QUALITY CONTROL OF DIET. R. J. Della Rosa, F. Gielow, and G. Peterson (California. Univ., Davis. School of Veterinary Medicine).

The quality control for the continuous feeding of a diet at five different specified Sr^{90}/Ca ratios is summarized. The constancy of the dietary calcium is maintained by control of natural materials only. Analytical procedures for quality control were instituted. (auth)

38638 (UCD-108(p.45-51)) SKELETAL UPTAKE OF INGESTED Sr^{90}: DISCRIMINATION AGAINST STRONTIUM IN GROWING BEAGLES CONTINUALLY INGESTING Sr^{90}. R. J. Della Rosa, F. Gielow, and G. Peterson (California. Univ., Davis. School of Veterinary Medicine).

The uptake of strontium in growing beagles continually ingesting Sr^{90} at constant Sr^{90}/Ca ratios has been determined from birth to 540 days (end of Sr^{90} feeding). The Sr^{90}/Ca ratio of bone in the newborn is about 0.1 that of the maternal diet; 0.2 during nursing, and reaches an equilibrium value of 0.4–0.5 soon after weaning. During nursing there is decreased discrimination against milk strontium; the Sr^{90}/Ca ratio of bone is about 0.8 that of beagle milk. (auth)

38639 (UCD-108(p.52-63)) URINARY AND FECAL EXCRETION OF Sr^{90} DURING THE 30-DAY PERIOD FOLLOWING END OF FEEDING. R. J. Della Rosa, F. Gielow, and G. Peterson (California. Univ., Davis. School of Veterinary Medicine).

The magnitude of the urinary and fecal excretion of Sr^{90} was determined in 10 experimental dogs during the 30-day equilibration period following the end of Sr^{90} feeding. Forty-eight hour samples obtained at this time indicate that the total excretion of Sr^{90} is about 0.2 $\mu C/48$ hours in the D5 level dogs. The urine to fecal ratio is approximately unity. The mean renal clearance values are 1 ml/min for Sr^{90} and 0.1 ml/min for calcium. The plasma disappearance curves of Sr^{90} following the end of Sr^{90} feeding indicate that the relative specific activities of the plasma and the exchangeable fraction of bone may be the same. To minimize possible cross-contamination problems, dogs in outdoor pens will be arranged in order of ascending and descending dose levels. (auth)

38640 (UCD-108(p.66-74)) STABLE STRONTIUM IN BIOLOGICAL MATERIALS. PART I. STRONTIUM ANALYSIS BY ION EXCHANGE SEPARATION AND FLAME PHOTOMETRY. An Interlaboratory Comparison. R. J. Della Rosa, R. Pool, and J. O'Sullivan (California. Univ., Davis. School of Veterinary Medicine).

Stable strontium has been determined in the food, bones, and milk of beagles by ion exchange separation and flame photometry. The results of an interlaboratory comparison of this method with neutron activation analysis indicate that food contains about 0.34 mg Sr/g ash and, bone and teeth about 0.23 mg Sr/g ash. Beagle milk was shown to contain approximately 0.1 mg Sr/g ash. The differential metabolism of calcium and stable strontium is similar to that of

Sr^{90} under conditions of continuous ingestion. The OR for stable strontium was found to be about 0.43. Data on the stable strontium content of food and bone permit the expression of Sr^{90} behavior in terms of stable strontium. (auth)

38641 (UCD-108(p.75-89)) STABLE STRONTIUM IN BIOLOGICAL MATERIALS. PART II. STRONTIUM ANALYSIS BY X-RAY EMISSION SPECTROSCOPY. M. Goldman, R. P. Anderson, and W. Gee (California. Univ., Davis. School of Veterinary Medicine).

Preliminary data are presented on the x-ray spectrochemical determination of natural strontium content of commercial dog feed and Beagle skeletons. Using ashed samples, nondestructive analysis of strontium is straight forward and gives routine standard deviations of less than 10% in the 200 to 400 $\mu g/g$ ash range. Sample handling and homogeneity are the main sources of error. Detection limits of submicrogram amounts are achieved on dilute solutions. Instrumental factors and sample preparation are discussed. (auth)

38642 (UCD-108(p.90-122)) WHOLE BODY COUNTING OF BEAGLES CONTINUALLY FED Sr^{90}. M. Goldman, L. Young, and R. Edmonds (California. Univ., Davis. School of Veterinary Medicine).

The design and use of a whole body counter to measure Sr^{90} bremsstrahlung is described. Instrumental and calibration factors are discussed. Preliminary data indicate a Sr^{90} detection sensitivity of about 0.1 μC Sr^{90} in 20 minutes of counting in dogs (about 10 kg) measured by an 8 in. × 4 in. NaI (Tl) crystal whose face is one meter from the midline of the dog. Information on the contribution of natural body radioactivity to Sr^{90} bremsstrahlung measurements is discussed. Data are presented from a colony of 79 dogs repeatedly counted during their 18 months on Sr^{90} diets; five different levels of Sr^{90} were used. Information is available from 11 sacrificed dogs of varying age and dose level for comparison of bremsstrahlung measurements with radiochemical estimates of body burden. Preliminary evidence suggests a dependence of bremsstrahlung detection upon body weight. The inference is that the bremsstrahlung detected are influenced by the degree of skeletal mineralization, the amount of skeleton present (which can absorb the $Sr^{90}-Y^{90}$ β rays) and the distribution of the soft tissue surrounding the skeleton. These biologic factors may also be reflected by a detector response. (auth)

38643 (UCD-108(p.123-42)) ION EXCHANGE DECONTAMINATION OF BIOLOGIC WASTES CONTAINING Sr^{90}. M. Goldman, R. P. Anderson, and F. Jassar (California. Univ., Davis. School of Veterinary Medicine).

Data are presented covering a second years operation of a waste treatment plant. Batch treatment results represent a marked improvement in decontamination over initial values. Clarification generally assists in the decontamination process. The 18 mC of Sr^{90} processed over the past year were decontaminated such that only 4.5 μC Sr^{90} were discharged from the plant. Studies on resin binding indicate that in addition to ion exchange a certain degree of filtration by the resin assists in reducing radioactivity concentrations and increases rate of resin expenditure. (auth)

38644 (UCD-108(p.143-4)) BLOOD VALUES IN Sr^{90} FED BEAGLES AT ONE YEAR OF AGE. A. C. Andersen and W. Gee (California. Univ., Davis. School of Veterinary Medicine).

Comparison of the blood samples which were taken at comparable ages (approximately one year) from Sr^{90} treated beagles on all dose levels, showed no difference in values for erythrocytic elements, between groups. An absolute depression in leukocytic elements was observed in dose levels 4 and 5. Blood sampling of treated dogs will be continued, in order to ascertain possible dose effects. (auth)

38645 (UCD-108(p.145-9)) PATHOLOGY REPORT. PART I. DOGS SACRIFICED FROM THE Sr^{90} FEEDING PROGRAM. A. C. Andersen (California. Univ., Davis. School of Veterinary Medicine).

Examination of tissues from dogs on the Sr^{90} feeding program which have been sacrificed to January 31, 1963, has yielded no consistent finding. Observation of pulmonary connective tissue foci or of an inflammatory lymphadenitis, in a few cases, has led to the use of more stringent prophylactic measures against ascarid infection, and to daily surveillance of velocity of air flow through the cages. (auth)

38646 (UCD-108(p.150-9)) PATHOLOGY REPORT. PART II. BEAGLE 5S2, A PRELIMINARY REPORT. A. C. Andersen (California. Univ., Davis. School of Veterinary Medicine).

One beagle succumbed to an osteogenic sarcoma at 1868 days of age. Only skeletal abnormalities were found—sarcomas of the humerus and tibia. In the latter, the neoplasm in association with necrosis was presumably the cause of decreased mineralization observed in roentgenograms. (auth)

38647 (WP/22/6) NUCLEAR MEDICINE. A GUIDE TO RECENT LITERATURE. List No. 6. (International Atomic Energy Agency, Vienna). Aug. 1963. 68p.

References are presented to publications in the field of nuclear medicine of interest to those who use radioisotopes in routine clinical practice. Topics covered include diagnostic applications of radioisotopes, local and systemic therapeutic applications of radioisotopes, therapeutic applications of radioisotope teletherapy and high-energy x-ray beams, and instrument developments. Author, journal, and isotope indexes are included. (C.H.)

38648 INTERSTITIAL RADIOISOTOPE IRRADIATION OF BRAIN TUMORS WITH COMPARATIVE LONG-TERM RESULTS OF DEEP X-RAY THERAPY. F. Mundinger (Neurochirurgische Universitätsklinik, Freiburg i.B.). Acta Neurochir., 11: 89-109(1963). (In German)

Radioisotope (Co^{60}, Ta^{182}, Ir^{192}, Au^{198}) implantation techniques for interstitial radiation are described, and comparative statistical evaluation is made for the mean survival time of 157 patients with primary tumors of the cerebral hemispheres. This series was treated with combined operative and interstitial radioisotope implantation therapy or with combined operative and deep radiation therapy. The percentage overall survival rate was 60% higher after postoperative interstitial radioisotope treatment. Among individual groups, in cases with glioblastoma with postoperative Co^{60} treatment there was a significant prolongation of mean survival time of ~29%, and with tumors in the frontal region there was a prolongation, depending on the dosage, of ~87% (16.8 months) or 106% (21.3 months). The 18% of patients still surviving show a mean survival time of 41.7 months. With astrocytoma there was no significant difference in the two groups. The treated patients who died of ependymona lived a significant 1.5 times longer (21.4 months), while the 50% of patients who survived to the present had a 54% improved mean survival time of 3.7 yr. The treated patients who died of oligodendroglioma showed a significant increase of mean survival time of 30% (21.8 months), while the 71% of patients still

surviving showed an increased mean survival time of 45% (64.9 months). Of the methods of interstitial irradiation investigated, Co^{60} postoperative treatment showed the best results. Undifferentiated or angioblastic meningiomata, which could not be completely removed at operation because of their site or because of technical difficulties (e.g., hemorrhage), were coated during operation with Ir^{192}. As a result of obliteration of the vessels and shrinkage of the remaining portion of the tumor, their subsequent total removal was made considerably easier. One advantage of interstitial radiation is the reduction of $\frac{3}{4}$ to $\frac{2}{3}$ in the time of treatment in comparison with deep radiation therapy. Dosimetry data are provided showing the distribution of dosage in brain tissues surrounding pellets of Co^{60} of various size, shape, and radioactivity. Protective devices for shielding other patients and medical personnel from hospitalized patients bearing these radioisotopes are described and illustrated. (BBB)

38649 COMPUTATION OF DOSES IN DERMATOLOGIC ROTATION THERAPY. P. Roenne (Universitet, Copenhagen). Acta Radiol. (N.S.), 1: 140-6(June 1963). (In English)

A method of covering large areas of the skin by rotating the patient during dermatological radiotherapy is described. The dose per revolution of the patient is calculated for the surface of the skin and for 1 mm depth at distances of 115 cm and 215 cm, respectively, between the focus and the axis of rotation. (auth)

38650 PRESERVATION OF OVARIAN FUNCTION IN EARLY CERVICAL CANCER AFTER SURGICAL LIFTING OF THE OVARIES AND RADIATION THERAPY. Carl Krebs, N. Blixenkrone-Moeller, and Vibeke Mosekilde (Univ. of Aarhus, Denmark). Acta Radiol., (N.S.), 1: 176-82(June 1963). (In English)

Attempts were made to preserve the ovarian function in young women with cervical carcinoma, stage I, by lifting the ovaries and attaching them to the parietal peritoneum on the psoas muscle or retroperitoneally to this muscle before radium irradiation. The attempts proved successful in 25 of 32 patients aged from 23 to 39. The possibility of a normal sex life was considerably increased. (auth)

38651 PRESUMPTIVE ISO-CHROMOSOMES FOR THE LONG ARM OF X IN MAN. ANALYSIS OF FIVE FAMILIES. J. Lindsten (Karolinska Hospital, Stockholm), M. Fraccaro, D. Ikkos, K. Kaijser, H. P. Klinger, and R. Luft. Ann. Human Genet., 26: 383-405(1963). (EUR-308.e)

The cytological study of five females is indicative of the existence in man of iso-chromosomes for the long arm of the X chromosome. Phenotypically the subjects are characterized by primary amenorrhea, short stature, elevated excretion of gonadotrophins, and low excretion of estrogens in urine. Laparotomy revealed in two of them gonadal streaks. Analysis of dermatoglyphics showed patterns similar to those found in XO individuals. The five subjects are sex chromatin positive in buccal mucosa smears and in cultured cells, and drumsticks are found consistently in their neutrophils. The karyotypes of the five patients are consistent in their appearance: in all the cells with forty-six chromosomes from different tissues (bone marrow, skin and blood) there are fifteen chromosomes in the 6-12-X group instead of sixteen, and an extra metacentric chromosome similar to those of pair no. 3. These cells are interpreted as having one normal X chromosome and a presumptive iso-chromosome for the long arm of X. In one or more of the tissues cultured from patients, there is a proportion of cells with forty-five chromosomes and an XO constitution. The origin of the iso-chromosomes is thought to be meiotic and paternal. This hypothesis is discussed on the basis of an apparent deficiency of females in the sibships of the patients and of the genetical information provided by the study of the sex-linked Xg blood group system in one family. This family, in which red-green color blindness is segregating, provides also evidence that the Xg and the red-green color blindness loci are located on the short arm of the X chromosome. Personal, family and laboratory data are provided in appendices, together with the cytological data and chromosome measurements. (auth)

38652 LIFE-LIKE FORMS IN METEORITES AND THE PROBLEMS OF ENVIRONMENTAL CONTROL ON THE MORPHOLOGY OF FOSSIL AND RECENT PROTOBIONTA. Ann. N. Y. Acad. Sci., 108: 339-616(June 29, 1963).

Twenty-three articles are included; separate abstracts were prepared for four. The remaining 19 articles not abstracted in NSA contain information on algae, diatom communities, cell structure and environment, bacteria, coricae and cysts, fossil algae, protists, and protobionta, and proteins and microparticles. (P.C.H.)

38653 EVALUATION OF RADIATION EFFECTS IN SPACE. Rainer Berger (Lockheed-California Co., Burbank). Ann. N. Y. Acad. Sci., 108: 482-6(June 29, 1963).

The aspects of the synthesis of complicated organic compounds from simple predecessors are discussed, because they offer clues to the evolution of organic compounds and to some degree to questions connected with studies on the origin of life. It is believed reasonable to assume that vast quantities of organic material are or were formed in space from which a fraction under special circumstances was the substrate for the evolution of life. (P.C.H.)

38654 OBSERVATIONS ON THE NATURE OF THE "ORGANIZED ELEMENTS" IN CARBONACEOUS CHONDRITES. Frank W. Fitch and Edward Anders (Univ. of Chicago). Ann. N. Y. Acad. Sci., 108: 495-513(June 29, 1963). (EFINS-62-28)

Studies were made on the carbonaceous chondrites Orgueil and Ivuna in order to determine the composition and number per milligram of organized elements. The most conspicuous particles found were circular, occurred in the abundance of several thousand per milligram, were opaque, and highly magnetic. The organized elements are classified into two types: those that have a highly structured morphology and those that have a much simpler appearance. The particles with highly structured morphology are less numerous than the simpler type, and appear to have a strong resemblance to common terrestrial contaminants. The particles of simpler morphology do not fluoresce, do not stain or stain atypically with biological stains, are soluble in acids, and seem to be of an inorganic composition and origin. It is believed that the present evidence is not adequate to suggest an extraterrestrial biological origin for the particles found in the carbonaceous chondrites. (P.C.H.)

38655 ON THE ORIGIN OF CARBONACEOUS CHONDRITES. Edward Anders (Univ. of Chicago). Ann. N. Y. Acad. Sci., 108: 514-33(June 29, 1963). (EFINS-62-27)

The nature of carbonaceous chondrites indicates that they were produced by the action of liquid water on a more primitive source material. Their mineralogy implies that the exposure to water occurred at temperatures near 300°K, a pH of 6–10, a reduction potential of ≤ -0.2 volts, and that it lasted for at least 10^3 years. Their high content of chalcophile trace elements and primordial noble gases suggests a source material more primitive than ordinary

chondrites; yet the presence of high-temperature minerals implies that the source material passed through at least one high-temperature stage. The exposure to liquid water could have occurred in subsurface regions of an asteroid heated by extinct radioactivity or another internal energy source. Sunlight for photosynthesis would not reach these regions, but an appreciable amount of free energy would be available from the conversion of olivine to hydrated silicates. Although this source of energy is finite, it may have served as the basis for the evolution of a nonphotosynthetic life form. None of the isotopic data suggest the presence of life, however. The fractionation between sulfur and sulfate in Orgueil is in the opposite direction from that observed for terrestrial sulfur bacteria. The carbon data are inconclusive, having been determined on the total combustible carbon only, rather than on individual compounds or fractions. The hydrocarbon data also are not conclusive. (P.C.H.)

38656 FURTHER OBSERVATIONS ON THE PROPERTIES OF THE "ORGANIZED ELEMENTS" IN CARBONACEOUS CHONDRITES. George Claus (New York Univ., New York), Bartholomew Nagy, and Dominic L. Europa. Ann. N. Y. Acad. Sci., 108: 580-605(June 29, 1963).

Consideration of the fine morphology, physical, and chemical tests, staining with biological stains, and further evaluation of contaminations suggest that the Orgueil, Ivuna, Tonk, and Alais carbonaceous meteorites contain indigenous, organic microstructures that seem to be of biogenic origin. The diagnostic value of morphological criteria is also discussed. (P.C.H.)

38657 QUANTITY OF RADIATION REACHING GONADAL AREAS DURING THERAPY. IV. FACTORS INFLUENCING OVARY DOSE. Victor H. Witten and Henry Lee (New York Univ., New York). Arch. Dermatol., 87: 591-600(May 1963).

Attempts were made to evaluate the circumstances influencing the quantity of radiation reaching the ovaries during dermatologic radiation therapy, and to devise effective methods for reducing the amount to well within acceptable limits. Measurements were made in a specially constructed, life-size, pressed-wood (masonite) phantom which could be used in almost any position that might be assumed by man during routine x-ray therapy, and with provisions for insertion of an ionization chamber at the anatomic site representing an ovary. The various parameters which might influence ovary dose during conventional dermatologic x-ray procedures that were studied included: x-ray quality (kvp), tube current (ma), beam collimation and field size, shielding, angle of the beam in relation to the ovaries, and proximity of treatment site to the ovaries. Ovarian dose was measured during irradiation of the face, upper chest, and back, using each of the parameters alone and then in various combinations. The results, presented in tables and graphs, show that in order to minimize ovary dose during dermatologic x-ray therapy, one should utilize lower tube kilovoltage, softer radiation, appropriate collimation, effective shielding (minimizing area of field irradiated) with no added filtration, increased distance between the x-ray beam axis and the ovaries, and angling on the x-ray tube away from the ovaries. The gonad dose can best be reduced by exerting all of these simple and inexpensive means every time dermatologic radiation is administered. However, from these measurements it was evident that of the body areas studied, some may be irradiated without fear of exceeding even the max permissible dose to the ovaries, whereas other areas cannot be treated with x-rays without overdosing the ovaries regardless of the precautions taken. (BBB)

38658 EXTENSIVE NECROSIS AFTER RADIATION FOR CANCER: EXPERIENCES IN SURGICAL MANAGEMENT. James E. Bennett and Darryl Carter (Ohio State Univ., Columbus). Arch. Surg., 86: 1061-8(June 1963).

Radionecrosis in skin and deeper tissues and its surgical repair are described in 16 cases. The observed epithelial changes included both atrophy and hypertrophy, but atrophy was the dominant feature. Epidermal hypertrophy, which preceded malignant change, developed more slowly and was less likely to occur in areas subjected to deep irradiation than in skin treated with multiple small doses of x-ray over a long period. The indolent ulceration that developed in skin augmented the changes in underlying tissues so that successful management of these ulcerations required adequate excision of the damaged area and replacement with fat-bearing pedicle flap tissue. When adjacent flaps were used, permanent blood supply to the region was assured. In cases of radiotherapy for basal cell carcinoma of the scalp, skin necrosis resulted in skull exposure with subsequent osteomyelitis and/or bone necrosis. Excision included the full thickness of the skull, and pedicle flap tissue from the scalp was used for coverage. Cranioplasty was performed after good skin and soft tissue cover had been obtained. Therapeutic radiation of the neck invariably produces marked skin changes, and when ulceration occurs, the vulnerability of underlying structures demands surgical treatment. Lesions of the upper extremity can be excised and covered with direct pedicle flaps from the trunk. Therapeutic radiation of the retroperitoneal area may produce extensive visceral damage as well as injury to the anterior abdominal wall, and anterior suprapubic ulcerations are particularly difficult to deal with since mobile adjacent tissue is scarce. The avascular midline is a limiting factor in flap design. Abdominal flaps extending onto the thigh can be used, but these require multiple delaying procedures to insure adequate blood supply. Patients being managed by these procedures are described. Most patients underwent their operative procedures with few serious complications. While postoperative bleeding and infection are inherent hazards, most complications were traceable to errors in planning or in operative technique. When the primary procedure fails, it is often many weeks before the wound is again ready for coverage and the availability of adjacent tissue has been compromised by the operation. Therefore, it is necessary to mobilize generous amounts of normal tissue to replace the area of injury, for this may be considerably more extensive than external inspection suggests. In addition, retraction of the wound edges following excision can be considerable since surrounding normal tissue may be drawn toward the area of involvement by scar contracture. When transposition or distant pedicle flaps are used, the flaps must be designed initially to allow for coverage of the eventual wound. However, when adjacent flaps are used, they may be outlined at the beginning of the procedure and appropriate alterations are then made, as necessary, after excision of the area of involvement. It is concluded that operation is not advisable until there is pain or ulceration in the region of radiation injury. Preferred treatment consists of excision of all damaged tissue with pedicle flap replacement. (BBB)

38659 THE INDICATIONS AND LIMITATIONS OF INTENSIVE RADIATION THERAPY. Franz Buschke (Univ. of California, San Francisco). Chicago Med., 65: 9-14 (Nov. 3, 1962).

Applications of radiation in the treatment of malignant diseases, in preference to surgery or other treatments, are enumerated. So many improvements in radiation therapy have evolved that radical radiation therapy is the primary

treatment of choice for about 40% of all patients with cancer in a stage for which there is still hope for permanent control. Selection of patients for radical radiation therapy, as determined by the type of tumor, by its extent, and by the patient's general condition, is discussed. The most important determinant is the type of tumor, since certain tumors are so irresponsive to ionizing irradiation that they are not amenable to curative radiation therapy (melanomas, fibrosarcomas, myxosarcomas, most but not all liposarcomas, osteogenic sarcomas). The extremely radiovulnerable tumors (lymphosarcomas, lymphoepitheliomas, anaplastic carcinomas, testicular tumors, Ewing's tumors of bone) show a tendency to early and rapid spread through the regional lymphatics, which makes them unsuitable for curative surgery even if removal is anatomically possible. The remaining large group of epidermoid and adenocarcinomas originating from the epithelial covering of the skin, mucous membranes, and mucocutaneous junctions represent special problems requiring judicious application of one or several types of treatment, the choice of which is discussed in detail. (BBB)

38660 SPLENIC IRRADIATION. J. Newall (Royal Infirmary, Edinburgh). Clin. Radiol., 14: 20-7(Jan. 1963).

Applications of splenic irradiation in various diseases are discussed and the attendant hazards are described. The normal organ can be irradiated to high dosage with no apparent untoward effects while irradiation of the diseased spleen may be followed by dramatic and at times disastrous changes. Splenic irradiation may be used as a method of treating the leukemias and as a means of controlling the pain of a grossly enlarged spleen. In most patients megavoltage offers no advantage over orthovoltage and there seems to be no need to include the whole organ within the irradiated fields. As a consequence there seems to be no point in using fields other than the standard 15 by 10 cm. In all instances, irradiation of the spleen must be governed by careful and regular blood counts, as a rule at least twice a week, with particular attention being paid to the platelets and white cell count. Results in patients with chronic myeloid leukemia treated by splenic irradiation over the past 20 yr are reviewed. In patients treated by 25 rad daily to each of two fields, no relation between the total white count and the required dose can be found. Examples where a high blood count has been reduced by a small dose of irradiation serve as a warning, so the ideal dose with which to start is probably 25 rad. If the blood count does not show an early dramatic fall then it is highly unlikely that this will occur subsequently, and treatment almost invariably continues uneventfully. Although these conclusions are based on treatment given at a rate of 25 rad daily, other rates show similar results. Splenic irradiation may also be of value in chronic lymphatic leukemic and hypersplenism of various organs. It proved to be useful in monocytic and acute leukemias. In 30 of 31 patients with malignant reticuloses, satisfactory relief of pain and reduction in the size of the organ were obtained with doses varying from 200 rad in five treatments to 2750 rad from a single field in 11 treatments. None of these patients showed any hematological upset before or following treatment. All seven patients suffering from follicular lymphoma and lymphadenoma showed a decrease in pain and reduction in organ size; dosage varied from 250 to 2500 rad in 10 treatments. Of eight patients with lymphosarcoma with normal peripheral blood pictures, only one derived no benefit following 1400 rad in 14 treatments, while all the rest improved with doses varying from 300 rad in 12 treatments to 2200 rad in nine. With one exception the spleen showed marked diminution in size. Splenic pain can also be reduced in patients suffering from myelosclerosis; however, in no instance should the total administered dose exceed 125 rad; and once the treatment has been given, no other radiotherapy should be given for at least one month. Even when the enlarged spleen is not a major source of blood formation, splenic irradiation provides a useful and possibly less upsetting alternative to splenectomy. In this instance the danger of aplasia induction is much less. (BBB)

38661 STEREOTAXIC IRRADIATION PROCEDURE OF BRAIN TUMORS AND PITUITARY ADENOMAS BY MEANS OF RADIOISOTOPES AND ITS RESULTS. F. Mundinger and T. Riechert (Universität, Freiburg i. B.). Confinia Neurol., 22: 190-203(1962). (In English)

The techniques, results, and complications of stereotactic implantation of P^{32}, Co^{60}, Ta^{182}, Ir^{192}, and Au^{198} in the brain of 196 patients for radiotherapy of intracranial tumors are described. A stereotactic instrument is described and illustrated which permits implantation of the radioisotopes to within 0.5 mm of the desired site. There was a clear relation between the length of survival and the kind of radioisotope applied, localization of the tumor, and amount of the tumor dosage. With glioblastomas, for instance, longest survival was noted in those with frontal localization, following Co^{60} irradiation, and an average tumor dosage of 10000 to 13000 r showed best results. Similar results, with even longer survival periods, were achieved in other dedifferentiated gliomas, in which the combination of intraoperative Ta^{182} or Ir^{192} implantation with a postoperative interstitial Co^{60} irradiation achieved the best results, in comparison with a combination of operation and x-ray therapy. The survival rate, which is nearly twice as high as in x-ray treatment, shows a significant relation to the average tumor dosage and tumor localization. The period of treatment was also shortened by 65-75% compared to the time required for fractionated x-ray therapy. In 68% of the stereotaxic hypophysis operations, according to the size of the tumor, a total activity of 25 to 55 mc of a macromolecular suspension of Au^{198} was implanted which was adsorbed on small graphite particles (50 to 60 μ). In the other cases small seeds of P^{32} were placed in the tumor. The long-term results show that visual acuity had improved significantly following secondary stereotaxic irradiation, or remained unaltered without change, in comparison to those patients that had been treated by operation only. On the other hand, the percentage of unimproved and deteriorated cases is much higher in the operated group. The operative mortality with primary stereotaxic punctures was nil, whereas surgical operative mortality totaled 19%. The survival rates of 90.4% of the patients with secondary stereotaxic irradiation and 76.1% with primary stereotaxic irradiation, in comparison with only 62% of patients with operation only, prove significantly that effectively implanted interstitial irradiation can prolong life. Among operative complications, damage to the neighboring structures was not caused by stereotaxic puncture, but was caused secondarily by radiation, above all by γ radiation. In six of the patients, therefore, an open decompression operation was necessary. There were some general transitory reactions in the first days, especially headache and cerebrospinal fluid pressure increase among recurrent and long-term complications, in 11.5%, visual acuity grew worse and the visual field was narrowed after 0.3 to 3 yr. It was concluded that primary, and especially secondary stereotaxic irradiation of hypophysis adenomas is clearly superior to surgical operation as concerns operative mortality as well as survival rate and rate of recurrence. The rate of improvement of visual acuity was 26 to

44% higher and that of the visual field 17 to 29% higher than following surgical operation only. However, one problem not yet solved satisfactorily is the long-term radiation damage of the chiasma and optic nerve. Perhaps filling the basal cisterns with x-ray contrast medium by means of the target needle, before the placing of the isotopes, may be of help in preventing this. (BBB)

38662 RADIOACTIVE XENON METHOD FOR DETERMINATION OF RESIDUAL VOLUME IN THE LUNGS. B. E. Votchal, V. K. Modestov, and M. A. Akopyan. Federation Proc., Transl. Suppl., 22: Pt. III, T855-6(Sept.-Oct. 1963).

A method is described for the determination of residual volume in the lungs that uses trace amounts of Xe^{133} mixed thoroughly with air in a closed system. The patient is connected to the system and a spirogram is recorded. The volume of the system is constant and activity is measured at minute intervals for several successive readings. The method is simple, convenient, and accurate. (C.H.)

38663 PREVENTION OF FEMALE CASTRATION IN RADIOTHERAPY OF THE LUMBAR SPINE. Claudio de Barros Barreto (Hospitais do Carmo, Rio de Janeiro). Hospital (Rio de Janeiro), 61: 1033-7(May 1962). (In Portuguese)

Investigation was made in 26 women with lumbar spondylitis who received x-ray treatment for their condition, and in which attempts were made to prevent injury to the ovaries thus affording protection against permanent amenorrhea, a frequent complication of lumbar irradiation of women. In the application of the x-rays, perpendicular incidence is abandoned, and two oblique fields of 10 × 15 cm are used, alternated at angles of 35-40° to the left and right of the spinal column. The 26 patients varied in age between 30-50 yr. Total incident x-ray dose was 200-500 r/hour per field, given in partial doses of 100 r twice a week at 200 kv and 0.5 Cu + 1.0 Al filtration and 50 cm distance. At follow-up, all women examined after x-ray treatment had normal menstrual periods. This method is therefore successful in protecting women against the development of amenorrhea from ovarian radiation injury. (BBB)

38664 A STUDY OF COLLIMATORS FOR USE IN RADIOISOTOPE SCANNING TECHNIQUES. T. D. Cradduck and S. O. Fedoruk (Univ. of Saskatchewan, Saskatoon, Can.). J. Can. Assoc. Radiologists, 13: 9-13(Mar. 1962).

A study was made to determine the validity of Brownell's theoretical results for the response of various collimators used in radioisotope scanning techniques. The isoresponse curves for three different collimators (single straight hole, single tapered hole, honeycomb) were measured in air and in water and compared with the theoretical ones. The in-air isoresponse curves compared favorably with those established by Brownell. A scattering medium such as water has a marked effect upon the curves, in that the point of max response, and correspondingly all others, are moved back towards the collimator face. The width of resolution at the point of max sensitivity is unaffected by a scattering medium. It was possible to determine the axial response for a particular collimator for I^{131} by assuming that its response in air is close to its theoretical response. This axial response may then be modified by the attenuating factor for I^{131} 364-kev γ rays, to give the axial response to be expected when the source is within a scattering medium. This axial response appears to be largely independent of the distance between the collimator and scattering medium, providing this distance is not too large. Thus, the response of the collimators to a source in a scattering medium may be approximated by the application of an attenuation correction to the theoretical or in-air response. It was concluded that a fair degree of accuracy may be assumed in designing a collimator, if Brownell's theoretical response is assumed and then corrected for attenuation in order to obtain the response in human tissue. (BBB)

38665 AN OXYGEN BAROTHERAPY APPARATUS FOR USE WITH THE 4-Mev ACCELERATOR. H. A. S. van den Brenk (Cancer Inst. Board, Melbourne). J. Coll. Radiol. Australasia, 5: 113-22(Dec. 1961).

Requirements governing the design of high-pressure oxygen equipment for use in radiotherapy are discussed and one such barotherapy apparatus is described and illustrated. This apparatus, manufactured by the Commonwealth Aircraft Corporation for the Peter MacCallum Clinic, Melbourne, is designed to operate at pressures of 60 psi oxygen (or less) in conjunction with a 4-Mev linear accelerator. It provides the means of obtaining a uniformity in dosimetry of tumors to be treated, comparable with conventional techniques. It also provides simple and accurate planning and positioning of patients before treatment, comparable with the conventional methods now in use. Multifield treatments can be given without decompression and recompression of the patient. The occupation time in the accelerator room is cut to a min and does not impose restrictions on the use of the accelerator for other purposes. Studies were made of the influence of the transparent plastic material used for portals in the apparatus, on the tissue dose. Interposing of a sheet of Perspex (or other material) between the target and the skin was found to modify the beam. The dose rate in air at the skin surface was decreased by absorption in the Perspex. However, this decrease was largely offset by using a 100-cm target-tumor center distance instead of 100-cm target-skin distance, and a dose rate in excess of 100 rad/min could be obtained. Even large single dose fractions of the order 1000 rad were thus easily managed. However, the depth in tissue at which the max absorbed dose rate (peak dose) occurred diminished as the distance between the inner surface of the Perspex and skin decreased. When the material is in contact with the skin the percentage skin dose is 100% while for a separation of 5 cm the percentage skin dose decreases to ~50% for a 25-cm^2 field. Although these factors did not seriously affect treatment, they had to be taken into consideration in providing corrected dosimetry and assessing skin reactions under high oxygen pressures. Isodose patterns obtained with the 4-Mev beam in the pressure vessel are illustrated. (BBB)

38666 STUDIES ON X-AGENT. I. CHANGE IN THE GROWTH RATE OF PROTEUS VULGARIS DUE TO INOCULATION TIME. Hideo Moriyama and Hiroshi Ueno (Shonan Hygiene Inst., Kamakura, Japan). Japan. J. Microbiol., 3: 387-95(1959). (In English)

The action of a postulated cosmic agent, presumably of an electromagnetic nature, was investigated in bacteria under various conditions. P. vulgaris cultured in peptone broth showed growth rates which were different depending on the time it was inoculated. Cultures inoculated in the morning consistently achieved better growth than those inoculated in the evening. In contrast, the production of NH_3-containing substances was lower in cultures inoculated in the moring than in the evening. Besides these diurnal changes, both the rate of growth and production of NH_3-containing substances underwent considerable change from day to day. The change was gradual and in one direction, probably seasonal, with fluctuations the periods of which appeared to be of a few days. Thus, the quantity and/or the quality of the agent shows both diurnal and seasonal fluctuations. (BBB)

38667 STUDIES ON X-AGENT. II. EFFECTS OF MATERIALS EXISTING OUTSIDE THE CULTURE MEDIA ON THE GROWTH OF PROTEUS VULGARIS. Hideo Moriyama and Hiroshi Ueno (Shonan Hygiene Inst., Kamakura, Japan). Japan. J. Microbiol., 3: 411-25(1959). (In English)

The influence of various types of shielding on the postulated cosmic (X) agent (cf. preceding abstract) was investigated. Glass tubes containing the peptone broth in which P. vulgaris was inoculated were covered with various materials, such as water, lead, and glass, and were left in an incubator for 1-2 days. It was found that the growth of the bacteria was markedly affected by the materials. The effect was observed not only when the bacterial cultures were covered by a material but also when they were in its close proximity. The effect was characteristic to the material, but other factors controlled the effect more than the nature of the materials. One such factor was the location of the material, another the time at which the observation was made. It is postulated that X-agent is altered in some way after penetrating the material, thereby yielding a secondary agent. The secondary agent is more responsible for affecting the bacteria placed near the material, it is proposed. Metals and nonmetals showed essentially different behavior toward the alleged agent. Directional as well as temporal variations in the intensity of the agent are also described. (BBB)

38668 STUDIES ON X-AGENT. III. EFFECT ON THE GROWTH OF SEEDS. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Japan. J. Microbiol., 4: 7-17 (1960). (In English)

The growth rate of seeds (grass and rape) was used to detect diurnal, seasonal, and directional variations in the intensity of this postulated cosmic radiation factor. As found earlier with bacteria, proximity to various materials changed the effect of the agent (cf. preceding abstract). (BBB)

38669 STUDIES ON X-AGENT. IV. EFFECT OF X-AGENT ON PROTEIN SOLUTION. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Japan. J. Microbiol., 4: 83-95(1960). (In English)

The effect of the X-agent, previously observed with both bacteria and seeds, was also demonstrated with protein solutions. The turbidity, or the transmittance, of an egg albumen solution was found to be influenced by materials present near it. The effect varied with the direction in which the protein solution was placed, in relation to the pattern of substances around it, in a complicated way. It is postulated that the X-agent may be involved in a change in the fine structure of the protein molecule, and that X-agent is capable of liberating certain active structures or radicals which affect the molecule. (BBB)

38670 STUDIES ON X-AGENT. V. EFFECT OF X-AGENT ON THE TURBIDITY OF PROTEIN [SOLUTIONS] OR ON THE GROWTH OF BACTERIA ARRANGED IN LINES OF VARIOUS DIRECTIONS. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Japan. J. Microbiol., 4: 229-42(1960). (In English)

To investigate the influence of this agent, transmittance of protein solutions in a series of test tubes was estimated after they were arranged in a row and left for several hours. It was found that the transmittance of the protein solutions varied according to a pattern along the line of tubes and with the direction of the line. The transmittance increased or decreased in a regular manner along the row of tubes. The pattern was repeatedly found to be accentuated in the direction extending north and south, and in most cases it varied with the day of observation. Similar phenomena were demonstrated with test tubes containing cultures of Proteus vulgaris, as seen by a difference in the growth rate of the bacteria. On certain days when the pattern of protein solution turbidity was very pronounced in a north-south direction, the pattern of the bacterial growth was also altered in this direction. It is suggested that X-agent has a tendency to progress along certain directions which may change with time. (BBB)

38671 EFFECTIVE HALF-LIFE OF RADIOACTIVE IODINE IN THERAPEUTIC DOSES FOR HYPERTHYROIDISM. Raul E. Adrian, Carlos R. Aiello, David Davidovich, Juan J. Staffieri, and Jose Solis (Centro de Endocrinologia y Metabolismo, Facultad de Ciencias Medicas, Rosario, Argentina). Medicina (Buenos Aires), 22: 185-8(Sept.-Oct. 1962). (In Spanish)

Tests were conducted in 25 hyperthyroid patients, who had never received radioiodine or antithyroid drugs, to determine whether the thyroid half-life value ($t_{\frac{1}{2}}$) of an exploratory dose of I^{131} could be used to calculate the required therapeutic dose. For an exploratory dose of 20 μC of I^{131} the $t_{\frac{1}{2}}$ value varied from 1.8 to 8.8 days, with a mean of 4.6 days. Higher $t_{\frac{1}{2}}$ values were found for the therapeutic dose (4.6 to 10.8 days, mean 6.9 days) in 21 of the 25 cases. This $t_{\frac{1}{2}}$ value approaches that of the euthyroid value (7.4 days). A possible explanation for this approach toward normal values is that the largest quantity of radiation is received during the first week, resulting in functional modification of the thyroid, although modification of the clinical picture usually shows up later. These results differ from those of several previous studies in which the therapeutic dose $t_{\frac{1}{2}}$ was lower than that of the test dose. Calculation of the thyroid dose in rads gives a mean of 7.5 rad, and the therapeutic $t_{\frac{1}{2}}$ value gives 11.4 rad. In an unpublished study of 25 other patients conducted with the purpose of evaluating the possible diagnostic use of the exploratory $t_{\frac{1}{2}}$, a value of 3.72 days was obtained. Thus the calculated amount of radiation received by the gland will differ appreciably when the estimations are based on the exploratory as compared with the therapeutic $t_{\frac{1}{2}}$ values. Furthermore, the test dose value provides only an approximation of the therapeutic dosage; other data are required for a more precise estimation. (BBB)

38672 CONTACT IRRADIATION OF THE BLADDER WITH A SEALED Sr^{90} SOURCE: EXPERIMENTAL STUDY. G. Peracchia and F. Mangione (Università, Parma, Italy). Minerva Fisioterap., 7: 365-79(Nov.-Dec. 1962). (In Italian)

Experiments were conducted in dogs in attempts to develop an improved method for intracavitary irradiation of cancers of the urinary bladder. The macroscopic and histologic response of the normal bladder to doses up to 30,000 r are reported. β radiation was provided by planchettes of nickel enclosing Sr^{90}. The planchettes, with a diameter of 9.5 mm and an activity of 50 mC (measured at the surface), were enclosed in Plexiglas and surgically introduced into the bladder. Four such planchettes were united in one plastic applicator to give an estimated surface dose of 3000 rep/min, which would be diminished 50% at a tissue depth of 1 mm, 75% at 2 mm, 88% at 3 mm, 94% at 4 mm, and 0% at 8 mm. In this manner, doses of 10,000, 20,000, and 30,000 r were delivered to the trigone and vault regions of vesicular mucosa. Macroscopic examination one month after 10,000-r exposure showed normal appearing mucosa and ureteral function, while histologically the surface epithelium appeared atrophic, the submucosa infiltrated with inflammatory cells, and the muscularis unaf-

fected. After 20,000 r the bladder surface was grossly edematous, hyperemic, and superficially necrotic, histologically, this necrosis extended into the submucosa but lower tissue layers were normal except for cellular infiltration. Fibrotic tissue later replaced the necrotic zones. Ulceration was more severe after 30,000 r and extended more deeply, into the muscularis, but ureteral function was maintained and healing of the atrophic mucosa occurred within several months by fibrosis. The possible clinical use of this technic for radiotherapy of superficial bladder tumors is discussed. (BBB)

38673 PURIFICATION OF RADIOACTIVE FOOT-AND-MOUTH DISEASE VIRUS. F. Brown and B. Cartwright (Research Inst. (Animal Virus Diseases), Pirbright, Surrey, Eng.). Nature, 199: 1168-70(Sept. 21, 1963).

Investigations on the purification of small quantities of radioactively labeled foot-and-mouth disease (FMD) virus are described. The results indicated that there is present in untreated virus suspensions and pellets a complex of the 7-mμ component and cellular material, which has the same sedimentation characteristics in sucrose density gradients as the 25-mμ infective component but is disrupted by deoxycholate into smaller components that sediment much more slowly in the sucrose gradient. The ratio of plaque-forming units and complement-fixing activity to radioactive counts in the individual fractions in sucrose gradients of deoxycholate-treated pellets was remarkably constant, indicating that the material in the peak was homogeneous. The experiments provided substantial evidence that the virus obtained from deoxycholate-treated pellets is free from substances found in uninfected cells. (P.C.H.)

38674 EXPERIMENTAL RADIOTHERAPY OF MALIGNANT TISSUES. Melvin R. Sikov (Wayne State Univ., Detroit). Progr. Expti. Tumor Res., 3: 296-320 (1963).

The results of animal experiments relating to eradication of tumors by ionizing radiations are extensively reviewed, with emphasis on the radiation effects on tumor and host, factors influencing the radiation response, prevention of metastases, and methods for improving the therapeutic response. In addition to citing 125 references, the author discusses his own published and unpublished studies. Conclusions based on earlier work are advanced. Attempts are made to distinguish between the direct effects of radiation on the tumor and the effects which are mediated through radiation changes in the host or in the tumor bed. Some recently tested means for enhancing radiotherapy, such as the use of labeled antibodies, oxygen at increased pressures, and combined therapy with various chemical substances are also reviewed. (TCO)

38675 INFLUENCE OF PHANTOM MATERIALS ON THE DEPTH-DOSE PERCENTAGE FOR RADIATIONS OF DIFFERENT ENERGIES. G. Tori, R. Miceli, A. Corinaldesi, and F. Bono (Università, Bologna). Radiol. Clin., 31: 111-21(1962). (In English)

By use of several sources of the high-energy radiations (Cs^{137}, Co^{60}, and 2-Mev Van de Graaff electrostatic generator) and conventional x rays, comparisons were made of ionimetric data to study the behavior of the radiations generated by each of these sources in phantoms of different materials which are usually employed in experimental radiological dosimetry: water, bolus alba, paraffin, talc, rice, and sodium bicarbonate. Preliminary experiments carried out on these materials, using various energy levels of radiation, indicated instances of analogous behavior between some of them; paraffin showed properties superimposable on those of rice and bicarbonate, bolus alba on those of talc. Water, on the other hand, had characteristics of its own. Thus a detailed examination was made of water, paraffin, and bolus alba with respect to surface and depth doses of radiations of different energies in phantoms of these materials. Changes in the surface dose, measured at the center of the field of irradiation when its area is varied, with 180-kev x rays and Cs^{137}, are similar in paraffin and bolus alba, but differ in water. The increase in surface dose according to the area of the field, is less marked for Co^{60} and 2-Mev radiation. These curves relative to Co^{60} and 2-Mev, both in paraffin and in water, are practically identical, the one superimposable on the other, while the Cs^{137} curve has a position midway between them and the 180-kv curve. In bolus alba, on the other hand, the Co^{60} and 2-Mev curves diverge; the depth dose percentage for Co^{60} is considerably greater. The Cs^{137} curve, even though it occupies an intermediate position in this material, is nearer to the high-energy curves than to that of 180 kv. Variations of the dose at a given depth (10 cm) in the materials in relation to the increase of the surface area showed that for the high energies (Co^{60} and 2-Mev electrons) the increase of the depth dose percentage relative to the area of the field is greater in paraffin than in water and bolus alba. For the Cs^{137}, on the other hand, the increase of the depth dose percentage shows no variation in the three materials, but 180-kv radiation, the increase is greater than for the other energies and is higher in paraffin than in water and bolus alba. Tests were made to determine which of the three materials approaches most nearly the absorption and diffusion conditions in various body regions irradiated with different energies. Values of the emergent dose in vivo were evaluated during irradiation of various parts of the body (skull, mediastinum, lung, medial abdomen, lateral abdomen, and thigh) in 30 patients. The emergent dose for each part of the body was expressed as a percentage of the incident dose. The ratio between the emergent doses for various irradiated body parts appear less for some than in others. For example, in thorax, since the thickness is made up for the most part by the lung, the values of the emergent dose are 10% of the incident dose in conventional and 39% in Co^{60} radiation. For denser anatomic parts such as the skull, the emergent dose values are, respectively, 6% and 43%. It follows that bolus alba for radiations of 180 kv is nearest to in vivo radiodensity, if the lung is excluded. For Cs^{137}, the material whose behavior most resembles that of living tissues is water; the same applies to 2-Mev radiation, again excepting the lung. However, water with Co^{60} gives doses similar to those in living tissues for the mediastinum, thigh, and central abdomen while for the skull and lateral abdomen, paraffin shows the values nearest to those noted in patient dosimetry. (BBB)

38676 SEARCH FOR ORGANIZED ELEMENTS IN CARBONACEOUS CHONDRITES. Edward Anders and Frank W. Fitch (Univ. of Chicago). Science, 138: 1392-9(Dec. 28, 1962). (EFINS-62-70)

A systematic search was made to detect substances of biological origin in a sample of the same Orgueil meteorite studied by Nagy et al. In the search, uv fluorescence, biological staining, insolubility in HF, and density less than 2.4 g/cm^3 were used as generic properties of organized elements. None of these properties were found to be adequate for the identification of organized elements. The samples used by Nagy and Claus were studied and found to contain a few particles of striking morphology which were not found in the previous samples, but the possibility of these particles being terrestrial contaminants is quite strong. Plastic-impregnated thin sections of Orgueil were

also examined and found to contain contaminants or artifacts. It is concluded that the problem of proving that rare particles having a highly structured morphology is not a terrestrial contaminant, is a very difficult one. (D.L.C.)

38677 CANCER THERAPY WITH FAST ELECTRONS OF 20 TO 30 Mev AND 35 Mev X RAYS. Werner Hellriegel (Universitäts-Rontgeninstitut, Frankfurt am Main). Strahlentherapie, 121: 481-94(Aug. 1963). (In German)

Today, fast electrons as well as ultrahard x rays are indispensable in modern radiation therapy. Better survival rates can be obtained with both kinds of radiation than with conventional x-ray therapy if they are used correctly. If the physical behavior of both kinds of rays in biological substance is known, then, supervoltage therapy is a simple kind of treatment. The calculation of focal dose for ultrahard x-rays is not difficult, since the doses measured directly at the phantom can be carried over to the tissue. In case of a homogeneous tissue structure the same procedure can be used for the fast electrons. (auth)

38678 SKELETON CHANGES AFTER HEMANGIOMA TREATMENT BY CONTACT IRRADIATION. Anton Luger, Erika Gross, and Ernst Kotscher (Universitat, Vienna). Strahlentherapie, 121: 532-48(Aug. 1963). (In German)

The changes in the skeleton secondary to hemangioma irradiation are reviewed from the literature. Those cases in which contact irradiation was done were discussed in detail. Furthermore, 96 patients with 108 disease foci are reported who mostly were irradiated with extremely high surface dose, in many cases at extended foci over the bone growth zones. After describing in detail the clinical nature of these foci, their localization, size, and radiation burden, the findings noted on x-ray examination of the skeleton, an average of 5 years and 7 months after the treatment, are reported. Fourteen out of 96 patients showed deviations from normal values. A connection with prior irradiation could be eliminated in 13 cases. In one case such a connection could not be eliminated with absolute certainty, but seemed to be very unlikely. The differences of the present results with those described in the literature might be explained by the fact that the radiation qualities used by other authors were considerably harder and higher dosages were administered more intensively. (auth)

38679 ON THE CALCULATION OF DOSE DISTRIBUTION WITH AN ELECTRONIC COMPUTER IN INTERSTITIAL APPLICATION OF RADIOACTIVE SEED (EXPLAINED FOR EXAMPLE OF RADIOGOLD SEEDS). Manfred Busch (Universitäts-Frauenklinik, Freiburg i. B.). Strahlentherapie, 121: 549-55(Aug. 1963). (In German)

A program for the determination of dose distribution in cases of interstitial application of radiogold seeds is developed using the electronic computer Si-2002. Calculated dose distributions agree completely with the measured ones. The instrument computes the doses of 1600 different points lying on a cross sectional area given by the seed arrangement. The results are printed on a sheet of paper with an enlarged scale distribution; the dose distribution can be read directly from the paper. Any location or size of the calculated dose distribution area can be chosen within great limitations. The program is applicable without change for interstitial or contact therapy with radium, cobalt-60, and other γ-ray emitters. Radiation absorption and scattering are considered in the calculation by using a constant. (auth)

38680 Y^{90}-TAGGED MICROSPHERES IN ADJUVANT TUMOR THERAPY. J. W. Lafave, I. Grotenhuis, Y. S. Kim, L. D. MacLean, and J. F. Perry, Jr. (Ancker Hospital, St. Paul, Minn.). Surgery, 53: 778-83(June 1963).

Experimental studies were conducted in rabbits to test the ability of injected radioactive particles to control the dissemination of a highly malignant tumor cell (V2 carcinoma) via the blood. Y^{90}-tagged ceramic microspheres (40-60 μ dia) with specific activity of 1 mC/mg were injected 5-10 min before or after intravenous injection of 500 tumor cells. Y^{90} spheres were employed in dosage of 3 mC in animals receiving tumor into the lungs and 6 mC in those in which tumor cells were allowed to embolize into the liver. All control animals demonstrated extensive tumor involvement. In contrast, most animals injected with spheres before or after injection of tumor cells into mesenteric vein were either tumor-free or minimally involved. Infusion of the spheres prior to the tumor cells enhanced the protection of the target organ. When injections were made into the ear vein, controls in each group averaged 20 or more tumor nodules per animal, while those receiving Y^{90} spheres averaged just over one tumor nodule per animal. Prior infusion of the microspheres may have enhanced lung protection, but the observed differences between prior and later injection of spheres were not statistically significant. An additional finding was that areas of hepatic involvement by tumor demonstrated much lower levels of radioactivity than tumor-free areas of liver. These studies demonstrate the protective effect of this form of interstitial radiation against this very virulent experimental tumor. The better over-all results obtained in animals with the pulmonary inoculation can be explained by the demonstrated fact that this tumor grows less rapidly in lungs than in liver. Furthermore, as the pulmonary tissue is less dense than hepatic tissue, it is possible that more uniform distribution of the radiation dosage was obtained in the lung. In light of studies of the mechanics of metastases, the enhanced protective effect of injecting the spheres just prior to the tumor cells is of interest. Previous studies with the V2 carcinoma demonstrated that malignant cells are characterized by decreased adhesiveness (force which resists separation of cells) and an increased stickiness (tendency to stick to a foreign substrate). Microspheres injected into the circulation become coated with a whitish substance, possibly fibrin, and often embolize in clumps. It is theorized that the spheres embolizing ahead of the tumor cells enmesh or block a significant number of them in vessels 50 μ or larger in dia, and that cells so enmeshed would be exposed to intense irradiation. When injected first, tumor cells embolizing in clumps could block large vessels, preventing distribution of the spheres and radioactivity beyond. (BBB)

38681 STUDY ON X-AGENT. VI. EFFECT OF X-AGENT ON RED BLOOD CELLS. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Tohoku J. Exptl. Med., 73: 127-46(1961). (In English)

Changes that were previously caused by the alleged X-agent in bacteria and protein solutions (cf. preceding abstracts) were also seen in erythrocytes. X-agent itself had no hemolytic action but appeared to exert an influence upon the cells, such that they will liberate hemoglobin in an amount dependent upon the intensity of X-agent in the presence of an adequate hemolytic agent. Stormlike fluctuations in the intensity of the agent in a north to south direction were observed, it is reported, in this hemolytic system as well as in protein solutions and bacterial cultures. It is suggested that humans may also be affected by stormy increases in the intensity of the agent. (BBB)

38682 CORONARY HEART DISEASE IN HIROSHIMA, JAPAN: ANALYSIS OF THE DATA AT THE INITIAL EXAMINATION, 1958-1960. Katsuhiko Yano and Shoichi Ueda (Atomic Bomb Casualty Commission, Hiroshima). Yale J. Biol. Med., 35: 504-22(June 1963).

A long-term epidemiological study of cardiovascular disease in Hiroshima, Japan, was conducted in order to: present data on the prevalence of CHD in a large sample of a Japanese urban population; demonstrate the association of certain physiological and clinical factors with the disease; and to compare the results with those obtained in a similar study on an American population. The original sample included 11000 men and women, aged 30 and over, with varying histories of exposure to ionizing radiation at the time of the 1945 atomic detonation. A total of 96 cases (48 men and 48 women) were diagnosed as having CHD at the initial examination. The prevalence rates were 1.4% for men and 0.8% for women. The prevalence of CHD using the same classification (definite infarction, angina pectoris, and possible infarction) was compared between the Hiroshima and Framingham, Mass., populations within the same age range. It was about 4 times as high in Framingham. The difference was particularly prominent in the younger age group. (P.C.H.)

38683 L'ENERGIA NUCLEARE IN AGRICOLTURA. VI CONGRESSO NUCLEARE DI ROMA 15-16 GIUGNO 1961. (Nuclear Energy in Agriculture. Sixth Nuclear Congress at Rome, June 15-16, 1961). Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. 486p. Prezzo Lire 3000.

Twenty-eight articles are included. Separate abstracts were prepared for 15. The 13 articles not abstracted in NSA include information on radioisotope techniques in agricultural research and applications of radioisotopes in zoology and agronomy. (P.C.H.)

38684 METHOD ADOPTED FOR MEASURING DOSES IN THE GAMMA FIELD OF THE CASACCIA. M. Giacomelli, G. T. Scarascia, and S. Tagliati (CNEN, Rome). p.33-53 of "l'Energia Nucleare in Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In Italian)

Methods used to calculate doses received by plants grown in the gamma field of the Casaccia Co^{60} source, with an activity of 175°C and a dose rate of 232 r/hr at 1 meter distance are described. By means of the Fricke chemical method it was possible to carry out an accurate dosimetry from the zones nearest the radiating unit to 1 meter distance from the source. In the remaining area of the gamma field, the systematical ascertainment of the dose rate was carried out by means of physical methods (ionization chamber). Measurements were carried out also at different heights from the soil, thus permitting the dose received in single parts and organs of the plant to be determined. The tables and criteria adopted in the case of acute or chronic irradiation are described, and the dosimetric procedures followed in the gamma field of the Casaccia are illustrated in detail. (auth)

38685 POSSIBILITIES OF USING REACTORS OF LOW POWER FOR RESEARCH IN AGRICULTURE. A. Sellerio (Scuola di Fisica Nucleare Applicata, Palermo, Italy). p.67-72 of "l'Energia Nucleare in Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In Italian)

The possibilities of using nuclear reactors of reduced power, for instance the A.G.N. 201 of Palermo, for research in the field of agriculture, are considered. Some experiments on irradiation of wheat and beans with neutrons are related. Furthermore, a technique is briefly reported, which was used and which permits the treatment of seed (or other material) with α rays obtained from the neutrons of the reactor by means of reactions (n,α). (P.C.H.)

38686 EFFECTS OF CHRONIC GAMMA RADIATION ON EMBRYOGENESIS IN CAPSELLA BURSA-PASTORIS MOENCH. M. Devreux (CNEN, Rome). p.197-217 of "l'Energia Nucleare in Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In Italian)

Capsella plants were irradiated, during the whole biological cycle, in a gamma field equipped with a Co^{60} source of 175 C. Several plants were disposed at various distances from the source and were given doses from 1127.6 to 3.62 r/day. Analyses of plant embryogenesis were made at 15 different doses. The anomalies in embryo development increased with the dose as well as the number of empty or incomplete embryo-sacs. The total number of ovules and their growth in the ovary decreased with the dose. The successive stages: impollination, pollen germination, pollen tubes growth, and fertilization were not stopped by irradiation. The first stages of pro-embryo formation were not the most sensitive. The formation of albumen usually went on regularly and did not depend on the embryo. The synchronism of the development of the embryos in different ovules in the same ovary was affected by irradiation. The vacuolization of embryo cells increased with the dose, several anomalies were found at different doses in the formation of the suspensors. The fertility of pollen grains of 23 plants that were daily irradiated at doses between 1127.6 and 32 r/d was analyzed at an interval of 20 days, in order to understand a possible influence of the cumulative effect of gamma radiation. The results, equal in both cases, showed that the dose rate is the main factor to be considered in flowers' analyses; the total dose given to the plant hasn't any influence at that level. (P.C.H.)

38687 RESEARCH ON THE EFFECTS OF RADIATION ON NICOTIANA. IV. MORPHOGENETIC, CYTOLOGIC AND BIOCHEMICAL MODIFICATIONS IN 23 SPECIES SUBJECTED TO CHRONIC GAMMA IRRADIATION. G. T. Scarascia, T. Cervigni, C. Dassiou, B. Donini, and M. Giacomelli (CNEN, Rome). p.219-34 of "l'Energia Nucleare in Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In Italian)

Twenty-three species of the genus Nicotiana were chronically irradiated in the Casaccia gamma field for the duration of their life; dose rates (in r/h) used were: 22–25 (dose I); 12–13.2 (dose II); 6–6.5 (dose III). Morphological (growth, leaf and flower characters, seed setting); cytological (pollen fertility); and biochemical (peroxidase activity, aminoacid content) effects were studied. The 23 species examined were subdivided into two classes of higher and lower radiosensitivity, respectively. In the first series were N. Alata, N. glutinosa, N. bigelovii, N. nudicaulis, N. sylvestris, N. repanda, N. debneyi, N. tabacum, N. knightiana, N. langsdorffii, and N. longiflora. Species ascribed to lower radiosensitivity were N. excelsior, N. suaveolens, N. pauciflora, N. corymbosa, N. paniculata, N. rustica var. pumila, N. acuminata, N. trigonophylla, N. megalosiphon, N. rustica var. brasilia. The most radiosensitive species were characterized by: increasing morphological damage with increasing dose (the strongest effect occurred in N. alata, which died after 9-week exposure to dose I); flowering inhibition at dose I; 20% reduction in pollen fertility at dose II); 50% reduction in pollen fer-

tility at dose III); and seed setting at dose III only. In addition the species were characterized by a low peroxidase activity, which, under chronic irradiation, increased with increasing dose rate (up to 10 times the control in N. alata). In the less radiosensitive species events were: pollen fertility 5–30%, 40%, and 60% at the 3 dose rates studied; seed setting in all species exposed to doses III and II and in 7 species out of the 12 exposed to dose I. A high peroxidase activity was also noticed, in all of the species, N. rustica excluded. Considering the results obtained in relation to polyploidy, it was found that the 4n species examined are almost equally distributed in the two radiosensibility classes. Probably, the protective effect of polyploidy was masked by other factors as nuclear size and mitotic cycle. (P.C.H.)

38688 EVALUATION OF THE USE OF INDUCED MICRO- AND MACRO-MUTATIONS IN THE BREEDING OF POLYPLOID CROP PLANTS. M. S. Swaminathan (Indian Agricultural Research Inst., New Delhi). p.241-77 of "l'Energia Nucleare in Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In English)

In a study on mutations induced in Triticum aestivum (2n = 42), Nicotiana tabacum, N. rustica (both 2n = 48), Gossypium hirsutum (2n = 52) and autotetraploid Hordeum vulgare (2n = 28), it was found that both with regard to the frequency of viable mutations and the fixable part of the variation in polygenically determined characters induced by radiation, bread wheat shows the maximum response followed by tobacco and upland cotton. There appears to exist a parallelism between the relative ability of these plants to yield mutations and to tolerate chromosome aberrations, thus suggesting that these two characteristics may be causally related. Several of the induced micro- and macro-mutations in bread wheat have proved to be of much economic interest. From among the radioinduced mutations, a new wheat variety, named N.P.836, which is fully awned and yields a little better than the parent strain, has developed. The awn character can be experimentally manipulated in wheat both qualitatively and quantitatively and it is estimated that the frequency of "positive" mutation in an awnleted wheat variety is of the order of 1 in 1000 M_2 plants. In tobacco and cotton radical changes occur in M_1, which are not inherited. Recurrent irradiation in M_2 and M_3 plants of cotton produces the same effect as the irradiation of F_1 seeds. Both chlorophyll and viable mutations start appearing in 4x barley from the M_3 generation. Mutation experiments indicate that by the use of appropriate techniques more subtle variations in phenotype (through the break-up of complex loci) as well as new characters not normally found within the limits of a species can be created. (P.C.H.)

38689 CHLOROPHYLL MUTATIONS INDUCED BY RADIATIONS AND CHEMICAL MUTAGENS ON DRY SEEDS. F. D'amato (Università, Pisa, Italy), G. T. Scarascia, A. Bozzini, and L. Monti. p.279-90 of "l'Energia Nucleare in Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In Italian)

The comparative mutagenic effects of radiations (x rays and thermal and fast neutrons) and chemical mutagens (β-propiolactone, ethyleneimine, diethyl-sulfate, and ethylmethanesulphonate) on dry seeds of the durum wheat varieties Aziziah and Capelli were studied. As shown by the survival data, Aziziah is clearly more radiosensitive than Capelli while the reverse is true with chemical mutagens. The frequency of chlorophyll mutations in M_2 in Aziziah and Cappelli is also reported. Criteria of analysis were frequencies of mutations per plant-progeny and per spike-progeny per cent and frequency of mutants per thousand M_2 individuals. Compared to the control values, the maximum mutation rates induced were 50–70 times higher on a spike-progeny basis and 340–370 times higher on a mutant-frequency basis. Moreover, in both varieties, it was apparent that: high mutation and mutant frequencies are induced by treatments decreasing by 30 to 70% the mean number of seedlings per M_1 spike (practically spike fertility) indicating that at least part of the chlorophyll mutations in durum wheat may be due to, or associated with, chromosome structural changes; and cases of more than one mutation per plant and/or per spike generally occur with thermal and fast neutrons. The 9 types of chlorophyll mutations ascertained in durum wheat and their relative frequencies are reported. Albina, xantha, xanthalba, chloro-albina were lethal; viridis and virido-albin were sometimes able to survive to maturity following greening of the plants. The remaining mutations were generally viable and fertile: lethality occurred only in some extreme forms of tigrina. (P.C.H.)

38690 MUTAGENIC EFFECTS OF X RAYS AND CHEMICAL SUBSTANCES STUDIED IN PARTICULAR GENOTYPES OF DORMANT SEEDS OF MAIZE. A. Bianchi, M. Contin, and E. Pozzi-Pardo (Università, Milan). p.291-308 of "l'Energia Nucleare in Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In Italian)

The frequency of albino or yellow-green sectors on yellow-green or green plants heterozygous for alleles of yg_2 locus on short arm of chromosome 9 of maize was used as a criterion of measuring mutagenic activity of several agents applied to dormant kernels. A very powerful mutagen turned out to be ethyl methanesulfonate. Diepoxibutane, known as a good inducer of endosperm mosaics when applied to mature pollen, turned out to be a poor mutagenic chemical when adsorbed by seed, in both its isomeric forms D and L. While the sector frequencies are quadratically related to x-ray doses, the same are linearly correlated to the ethyl methanesulfonate concentrations (0.0625–0.5% solutions, for 24 hours, at about 20°C). With a given x-ray dose, a great reduction was observed passing from a leaf to the following one. This is so, to a much reduced degree, when two successive leaves of plants treated with ethyl methanesulfonate are scored. Very dry (moisture content 6% or less) or very moist (water content 30%) seeds are more radiosensitive than seeds with intermediate moisture content, when x irradiated (6 kr). On the contrary, the same range of moisture values does not appear to affect the mutation response in the case of chemical mutagenesis obtained with ethyl methanesulfonate. Using seed heterozygous for lc (lycopene factor, likely located on chromosome 5, producing in homozygous condition albino seedlings) the results were substantially the same as with the previous genotypes. The different relationships existing between genetic effects and x-ray doses or ethyl methanesulfonate concentrations, as well as the different response of the successive leaves seems to confirm the suggestions that while the physical agent acts in maize chiefly by the production of chromosome breaks, the chemical produces none or few two hits events. (auth)

38691 EFFECTS OF PHYSICAL AND CHEMICAL MUTAGENIC AGENTS ON THE DEVELOPMENT OF SEEDLINGS OF VICIA SPP. FOR FODDER. L. Zannone (Istituto Nazionale di Genetica per la Cerealicoltura N. Strampelli, Rome). p.309-33 of "l'Energia Nucleare in

Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In Italian)

The sensitivity of some species of fodder-vetches (V. sativa, V. ervilia, V. villosa and V. glabrescens) in respect to physical and chemical mutation inducing agents was tested. The treatments used on dormant seeds and the relative doses were: x-rays: 14, 21, 28, 35, 42 kr; gamma rays: 15, 20, 25, 30, 35, 40 kr; fast neutrons: 200, 400, 500, 800, 1000, 1200 rep; ethylenimine: 0.01, 0.02, 0.03, 0.04, 0.06% in weight; and ethyl-methanesulfonate: 0.05, 0.10, 0.15, 0.20, 0.30% in weight. The different sensitivity of the species was estimated within each treatment on the basis of the mean development of the seedlings deriving from treated seeds and expressed as percentage of the mean development of the respective controls. A considerable difference of response was observed in the species and biotypes examined, as far as the germinability and the development of seedlings were concerned. Generally V. ervilia and V. sativa (biotype 78/5) demonstrated a considerable sensitivity in respect to both physical and chemical agents, while V. villosa resulted in all cases scarcely sensitive. V. villosa glabrescens revealed a considerable sensitivity in respect to physical agents and a poor sensitivity in respect to chemical agents. (auth)

38692 CORRELATION BETWEEN MORPHOLOGICAL CHARACTERS OF SEEDLINGS FROM IRRADIATED SEEDS OR THOSE TREATED WITH CHEMICAL MUTAGENS IN VICIA SATIVA L. AND V. VILLOSA ROTH. G. Mariani and L. Zannone (Istituto Nazionale di Genetica per la Cerealicoltura N. Strampelli, Rome). p.335-47 of "l'Energia Nucleare in Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In Italian)

With the purpose of studying the possibility of proceeding in Vicia to the estimate of the direct effect of treatments carried out on the seed by means of measures not connected with the rate of germination and of growth of the seedlings, a series of morphological characters was the object of measurements on Vicia sativa and V. villosa seedlings deriving from seed treated with x rays (14 and 28 kr), ethylmethane sulfonate (0.10 and 0.20% for 24 hours), and ethylenimine (0.03 and 0.06% for 6 hours). The existence of a high correlation was ascertained between the height of the seedlings that is commonly used for the measurement of the direct effect of treatments on the seed, and the length of the stem between the first scale and the insertion mode of the first leave, as well as between the height itself and the length of the first leaflet of the first leaf; the correlation coefficients were found to be $r = +0.88$ and $r = +0.93$, respectively. An equally high correlation was ascertained by analyzing the data independently within biotypes, treatments, and doses. (P.C.H.)

38693 FURTHER DATA ON POLYGENIC MUTABILITY INDUCED BY X RAYS IN NICOTIANA TABACUM L. G. Wittmer (Istituto Scientifico Sperimentale per i Tabacchi, Rome). p.349-60 of "l'Energia Nucleare in Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In Italian)

An analysis was carried out on the R_3 generation of the irradiated tobacco plant bred subsequently on the field according to a plan more apt to discriminate and the various fractions constituting the total phenotypical variance were evaluated. The analysis of variance was conducted according to a hierarchic plan and independently for each treatment; the most interesting results were for four metrical traits of the flower (width of the fauces of the flower; width of the internal part of the brim; base and length of the longer lobe of the corolla), the genetic variability, of which the variance among plants within lines gives an estimate, was several times greater in treated lines than in the control lines; with reference to each dosis, the variance among plants within lines, in which it is possible to identify a part of variability pertaining to the segregation of the possibility induced mutations, was always significantly increased in the lines treated, while in the controls it was not increased in respect to residual variance, which comprises the major fraction of variance due to environmental influences. This suggests that in the control lines there has hence been no segregation, while in the treated lines there has occurred a segregation of induced mutations. (P.C.H.)

38694 THE TIME FACTOR IN ARTIFICIAL MUTAGENESIS FROM X RAYS IN MAIZE. M. Contin, A. Bianchi, and S. Patruno (Università, Milan). p.361-75 of "l'Energia Nucleare in Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In Italian)

The frequency of albino or yellow-green sectors on corresponding yellow-green or green plants heterozygous for alleles of yg_2 locus on short arm of chromosome 9 of maize was used as a criterion for measuring the visible somatic mutation rate in seedling sprouted from various x irradiated seeds. Experiments were carried out to determine the influence of continuous vs fractionated doses, as well as of high vs low radiation rate. In the first series of treatment the dose used was 6 kr, administered in a single period of 10 minutes or fractionated in 4 treatments at intervals varying from 5 to 160 minutes. The different radiation rates ranged from 20 to 600 r/min. The water content of the seed was either 4 or 10–12%, at the irradiation time. Within the limits of such experiments, the various treatments were not effective in altering the genetic results. No systematic differences were found in the numerous comparisons possible between the different treatments, on the basis of the number of somatic mutations scored on leaves 2 to 5 (mainly 3 and 4), the only effective factor turned out to be the water content of the seed. The results suggest that the successive fractions of a given x-ray treatment are simply additive in producing genetic effects in dormant maize seeds. (P.C.H.)

38695 FOOD IRRADIATION—PROSPECTS FOR INTERNATIONAL COOPERATION. E. Sealand. p.385-414 of "l'Energia Nucleare in Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In English)

A survey was made of the present status of food irradiation, and possible trends in the field, in particular possibilities for international cooperation, are indicated. Special emphasis is given to international aspects of the problem. Results of previous tests on sprout inhibition in potatoes, pasteurization of fruit juices, treatment of dried and frozen whole eggs against salmonella, are discussed. A survey of existing facilities and programs for food irradiation in the O.E.E.C. countries is also given. (P.C.H.)

38696 THE STERILIZATION OF FOODS BY MEANS OF IONIZING RADIATIONS. A. Porretta (Stazione Sperimentale per l'Industria delle Conserve Alimentari, Parma, Italy). p.415-26 of "l'Energia Nucleare in Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In Italian)

The main advantages and disadvantages inherent in the sterilization of food by means of ionizing radiations in comparison with the traditional Appert system, which is founded upon the use of high temperatures, were examined. The new sterilizing method destroys, just as the thermal

treatment, the microbic flora existing in the foodstuffs, but does not inactivate the enzymes excepting the case of doses of energy so high as to cause serious alterations. Besides, both methods (heat and radiations) are incapable of controlling alterations of chemical origin. In respect to the thermal treatment, irradiation presents the following main disadvantages: it does not inactivate the enzymes, causes unpleasant odors and tastes, and is more expensive. (auth)

38697 MODIFICATIONS OF GLUTEN PROTEINS AFTER TREATMENT WITH GAMMA RAYS. A. R. Deschreider (Ministère des Affaires Economiques et de l'Energie, Brussels). p.427-37 of "l'Energia Nucleare in Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In Italian)

Lactic extracts obtained after treating gluten with Zeleny liquor, gave electrophoregrams on paper at pH 2.5, which were characterized by three groups of proteins: 0, 1, and 2. The group 0, which is immobile, was formed mainly by proteins soluble in diluted lactic acid, group 1, which is mobile, was formed by proteins soluble in alcohol 57% (vol/vol) and group 2, the most mobile one, was above all present in the extracts alcohol-acetic acid, 0.1N (vol/vol). The centesimal repartition of these groups in the Zeleny extract was affected by the gamma rays in such a manner that group 2 decreased and the same happened for the immobile 0 proteins, which are denaturated, causing the increase of the proteins 1 soluble in diluted alcohol. The changes were accompanied by modifications in the ultraviolet absorption of the proteins, which affect not only the whole spectrum but also certain absorption bands. There exists a marked similarity among the modifications created by the gamma rays, heat, and uv rays of 2537 Å wavelength. Thus the 2537 Å uv and gamma rays, both cause changes in the absorption bands and a general augmentation of the uv spectrum of the proteins proportional to the energy applied. The heat factor, uv 2537 Å, and gamma radiation have a similar action on the proteins of the groups 0 and 1 in the sense that they increase the proteins soluble in dilute alcohol at the expense of those that are extractable by lactic acid. This phenomenon is proportional on the one hand to the intensity of the gamma radiation and on the other hand to time for the 2537 Å uv rays and for the heat. (auth)

38698 BIOLOGICAL PROBLEMS CONCERNING THE RADIO-PASTEURIZATION OF FRUIT AND VEGETABLES. A. Mariani and M. A. Spadoni (Istituto Nazionale della Nutrizione, Rome). p.457-65 of "l'Energia Nucleare in Agricoltura." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1963. (In Italian)

Starting from some observations on the availabilities and consumptions of vegetables and fruit in Italy, the prospects offered by radiopasteurization as a means of prolonging their state of preservation and saleability were considered, also in consideration of the problem of exports. The biological problems, which have to be considered, are connected, on the one hand, with the microorganisms responsible for the spoilage with particular reference to the possibility of the existence of differences for products of different origin; and, on the other hand, with the necessity of undertaking long term studies in respect to wholesomeness. In this regard, a fundamental problem is constituted, among others, by the choice of animals suited to this kind of experiment. Finally, the foodstuffs of vegetable origin, which it seems advisable to examine in the first place, are indicated. (auth)

38699 DEVICE FOR IRRADIATING WITH RADIOACTIVE SUBSTANCES. J. Dowidat and W. Waschke (to E. Uhlhorn and Co., GmbH). German Patent 1,149,134. May 22, 1963. Filed Mar. 16, 1960.

The device described is in the nature of an applicator consisting of a receptacle, e.g., a capsule, for the radioactive substance bearing a demountable handle which is attached to the receptacle, and a shield with a central opening to receive that end of the handle to which the receptacle is attached. In order to achieve that the preparatory work necessary for the application can be done before the applicator is positioned, a frame is provided which is attached to the body of the patient by straps or other known means. This frame is shaped so that the receptacle can be fitted into it but can also be removed. (NPO)

Biochemistry, Nutrition, and Toxicology

38700 (BNL-6737) CELL POPULATION KINETICS OF AN OSTEOGENIC TISSUE. [PART] I. Maureen Owen (Gt. Brit. Medical Research Council. Bone-seeking Isotopes Unit, Churchill Hospital, Oxford and Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT-30-2-GEN-16. 35p.

Cell proliferation on the actively growing periosteal surface of the femur of rabbits aged two weeks has been investigated using autoradiographic techniques. Injections of tritiated glycine and tritiated thymidine were given simultaneously and the animals sacrificed at intervals from 1 hr to 5 days after injection. The glycine labeled the position of the bone surface at the time of injection and the thymidine labeled the cells which were synthesizing DNA. The rate of increase in the cell population was determined by counting the number of cells beyond the glycine label at different times after injection. The cell kinetics of the fibroblast–pre-osteoblast-osteoblast-osteocyte system were studied. The fibroblasts are relatively unimportant from the point of view of increase in the cell population. The main site of cell proliferation is the layer of pre-osteoblasts on the periosteal surface. The rate of movement of cells from the pre-osteoblast to the osteoblast and osteocyte compartments was measured. The incorporation of osteoblasts into the bone is not a random process, but it appears that the osteoblast must spend a certain time on the periosteal surface before becoming either an osteocyte or a relatively inactive osteoblast lining a haversian canal. During its most active period on the periosteal surface it was estimated that on an average, an osteoblast produces 2 or 3 times its own volume of matrix. (auth)

38701 (BNL-6738) CELL POPULATION KINETICS OF AN OSTEOGENIC TISSUE. [PART] II. Maureen Owen and Sheila MacPherson (Gt. Brit. Medical Research Council. Bone-seeking Isotopes Unit, Churchill Hospital, Oxford and Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 37p.

Data are presented from a study of the cell kinetics of the actively growing periosteal surface of the femur of rabbits aged two weeks. A single injection of tritiated thymidine was given and the rabbits killed from one hour to four days after injection. The grain count spectra of the different cell types, pre-osteoblast, osteoblast, and osteocyte, were compared at different times after injection. The results showed evidence for the uptake of thymidine in nuclei which is not associated with cell division. A small percentage of osteoblasts was initially labeled at one hour, and there was evidence that the majority of these had not di-

vided by 3 or 4 days after injection. Some thymidine-labeled cells had also become osteocytes without division. Furthermore, it appeared that a considerable fraction of the initially labeled pre-osteoblasts did not divide. The S-period for the pre-osteoblasts and osteoblasts was measured using a double-labeled thymidine technique. (auth)

38702 (BNL-6822) A NOTE CONCERNING THE "100% VALUE" IN IRON ABSORPTION STUDIES BY WHOLE BODY COUNTING. L. Schiffer, D. C. Price, J. Cuttner, S. H. Cohn, and E. P. Cronkite (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT-30-2-GEN-16. 12p.

The 4-hr whole-body count was found to be a reliable standard for the 100% value in Fe absorption studies performed with a whole-body counter. Valid measurements of Fe absorption can be made after 2 weeks postingestion of Fe^{59}, but not prior to this period. (auth)

38703 (BNL-7177) UPTAKE AND TRANSFER OF FALLOUT I^{131} IN PREGNANT WOMEN. S. H. Cohn and E. A. Gusmano (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract [AT(30-2)-Gen-16]. 4p. (CONF-66-9).

From Symposium on the Biology of Radioiodine, Richland, Wash., June 1963.

Levels of I^{131} in pregnant women and controls were determined by whole-body counting with a scintillation crystal placed over the thyroid. No detectable levels of I^{131} were found. Ten fetal thyroids and milk samples were also negative for I^{131}. In a second series counted during Oct. through Dec. 1962, levels of I^{131} in pregnant women ranged from 0 to 160 pC. In 5 of the offspring of these women measured from 18 to 34 days after birth, no significant levels of I^{131} were detected. Levels of I^{131} in milk samples collected during this period ranged from 25 to 180 pC/qt. Apparently no more I^{131} was taken up by pregnant than by nonpregnant women. The data suggest a correlation between milk consumption and thyroid I^{131} content. (C.H.)

38704 (BNL-7252) TRANSPORT, HOMEOSTASIS AND SPECIFICITY IN TRACE METAL METABOLISM. George C. Cotzias (Brookhaven National Lab., Upton, N. Y.). [Aug. 5, 1963]. Contract [AT(30-2)-Gen-16]. 42p. (CONF-215-1)

From 6th Congress of Nutrition, Edinburgh, Scotland, Aug. 1963.

The recent development of sharp analytical resolution has permitted world-wide initiation of integrated studies of the kinetics, the physical state, and the chemical behavior of trace metals in relation to their concentration. Nonetheless, it had already become evident that these metallic nutrients might be more essential to life than even oxygen, since only some living things require the latter while all of them seem to require the former. Two essential metals, Mn and Zn and a non-essential one, Cd, are followed through considerable portions of their respective pathways through the body. The pathways are examined with regard to their biological specificity. Attention is given to the role of the liver and other tributaries of the gastrointestinal system as surrogate kidneys in homeostasis. Methodology is touched upon with emphasis on isotopes and the analytical potential of nuclear reactors. Several distortions of homeostatic regulation are considered with regard to their nutritional, clinical, and biochemical meaning. The homeostatic role of some drugs is indicated. (auth)

38705 (CONF-244-1) BOVINE THYROID I^{131} IN THE ABSENCE OF ATMOSPHERIC NUCLEAR WEAPONS TESTS. Clifton Blincoe and V. R. Bohman (Nevada. Univ., Reno). 1962. Contract AT(04-3)-34. 7p.

From American Society of Animal Science Western Section, Laramie, Wyo., July 1962.

Cattle in Reno, Nevada, exhibit a constant very low concentration of I^{131} in their thyroid glands in the absence of known releases of I^{131} to the atmosphere. This concentration is about 1 pC/g of fresh thyroid tissue. This I^{131} appears to originate below the tropopause. (auth)

38706 (UCRL-10898) THE ELECTRIC CHARGE AND SURFACE PROPERTIES OF INTACT CELLS (thesis). Robert M. Glaeser (California. Univ., Berkeley. Lawrence Radiation Lab.). July 30, 1963. Contract W-7405-eng-48. 165p.

Henry's theoretical treatment of the electrophoresis of colloidal particles is reviewed, and derivations are given for important steps omitted in his paper. The point that the charge need not be only at the outer surface is given special emphasis. Certain observations from the literature that lead to the hypothesis that there might be a net charge in the interior of most cells (e.g., associated with membrane potentials, active ion transport) which contributed appreciably to the net charge on the cell are reviewed. Measurements are reported on mobility as a function of pH and ionic strength for a number of different kinds of intact cells. Data on their isoelectric points, and the time dependence of the mobility of erythrocytes at pH 3.1 that give indirect support to this hypothesis are reported. The hypothesis is, however, rejected on the basis of negative experimental results and other observations from the literature. Therefore, it is concluded that the net charge on intact cells exists almost exclusively at the outer surface. The surface properties of intact cells, primarily rat erythrocytes (RBC), were investigated by the method of microelectrophoresis in conjunction with enzymatic and chemical treatment. The discovery is reported that α-amylase (a glycosidase) releases bound sialic acid from RBC. This, together with earlier work using the receptor-destroying enzyme and proteolytic enzymes, already reported in the literature, implies that there is a protein-associated oligosaccharide at the outermost surface of the rat RBC. Fixation with OsO_4 allowed the measurement of both a positive mobility for RBC below the isoelectric point at pH 1.6, ionic strength 0.145, and an increase in the absolute value of the mobility above pH 11.0. The entire mobility-pH curve from pH 0.9 to 12.3 is consistent with the hypothesis that sialic acid is chiefly responsible for the surface charge. This hypothesis is also consistent with calculations regarding the electrokinetic charge, the surface area, the amount of sialic acid, and the total carbohydrate. Preliminary electron microscope studies of rat RBC show a pebbly surface structure previously described for RBC of several other species, in addition to a curious tangled rope structure. A tentative suggestion as to the structure of the cell membrane is proposed on the basis of these studies. (auth)

38707 FURTHER ATTEMPTS TO INFLUENCE THE ELIMINATION OF RADIOSTRONTIUM. Arne Nelson, Curt Roennbaeck, and Lena Rosén (Research Inst. of National Defence, Sundbyberg, Sweden). Acta Radiol. (N.S.), 1: 129-39(June 1963). (In English)

Gamma spectrometry was tested as a method of measuring strontium-85 in living animals. Male CBA mice were injected intraperitoneally with 0.1 μC carrier-free Sr^{85}. Various agents that influence the retention of radiostrontium were administered prior to and following Sr^{85}-injection. Measurements of activity were made in a small-

animal-counter 3 min and 1, 3, 7, and 14 days afterwards. The mean value of the retention of the control groups at 7 days was used as the standard value with which results of treated groups were compared. Of the agents tested strontium chloride and magnesium sulfate were found to be more effective in decreasing radiostrontium retention. No dose dependent effect of inactive strontium was observed within the dose range investigated. Results were in good agreement with those of previous attempts to influence the retention of radiostrontium in mice when Sr^{90} was used. (H.M.G.)

38708 RADIOISOTOPE (I^{131}) STUDIES OF PLACENTAL LOCATION AND CIRCULATION. Donald P. Swartz, Melville A. Platt, and Fred C. Heagy (Harlem Hospital Center, New York). Am. J. Obstet. Gynecol., 85: 338-44(Feb. 1, 1963).

A modified isotope method, requiring lower levels of radioactivity, for localization of the placenta is presented and its application in 66 patients described. A dose of 3.0 μC of radioiodinated human serum albumin was injected into the antecubital vein, and after 10 min a collimated scintillation detector connected to a count rate meter was used to count radioactivity in a reference position over the precordium and in 21 positions around the uterus. Administration of iodine as Lugol's solution, prior to and after the radioisotope study, reduces the thyroid exposure markedly so that the total-body irradiation to both mother and fetus is significantly less than that from one or two diagnostic x-ray exposures of the abdomen. Although earlier methods employ 10.0 μC of I^{131} and more recent reports maintain that 5.0 μC is a min dose, satisfactory results were obtained with 3.0 μC of I^{131}-labeled albumin. Various abdominal scanning patterns are illustrated for anomalous placental locations and obstetric problems. Fetal death in some instances was associated with elevated isotope counts which were consistent with placental localization. In cases of intrauterine death, there were differences in the maternal placental circulation which varied with the duration of the retention of the dead fetus. In several cases there was an early period of marked reduction of maternal placental blood flow followed by a return of this circulation to its previous level or even to a higher level. Thus, there is a possibility that after fetal death there is an early phase of shutdown of the major maternal placental circulation and that during this phase, isotope studies fail to localize the placenta. (BBB)

38709 ACTION OF HIGH DOSES OF PARATHORMONE ON THE BEHAVIOR OF STRONTIUM AND CALCIUM IN BONE AND BLOOD SERUM: A CONTRIBUTION TO THE MECHANISM OF ACTION OF PARATHORMONE. A. Schmid and K. Zipf (Universität, München). Biochem. Z., 333: 529-33(1961). (In German)

Rats were fed Sr-containing diets for 23 or 60 days and then with a standard Ca-containing diet for 30 days during which Sr and Ca assays were made in bone and blood. During this 30-day period, some of the rats were injected daily with high doses of parathyroid hormone (1 or 2 USP units per day) to determine the influence of the hormone on elimination of Sr from the skeleton. Samples of compact (tibia + femur) and spongy (vertebra) bone were ashed and analyzed. In both kinds of bone and in both sexes, the hormone caused a delay in removal of Sr from the skeleton. In compact bone Sr content of the ash was about 5% greater 30 days after treatment with 1 unit/day than in the absence of treatment. In spongiosa the difference was ~10%. Calcium contents were not significantly affected in either type of bone. In both sexes, hormone treatment increased the Sr and decreased the Ca levels in serum. E.g., 30 days after treatment with 2 units/day the Sr levels were 5.84 and 5.28 mg% in males and females compared to levels of 5.12 and 3.83 in rats not treated with the hormone. The results are explained in terms of the greater stability of Sr than Ca with citrate, lactate, and other chelating metabolites, which promote the mobilization of bone mineral under the influence of parathyroid hormone. The cation-organic acid complex thus formed results in higher serum levels and lower renal excretion of Sr as compared with Ca ions. An effect similar to that shown with the hormone could be demonstrated in animals treated with fluoroacetate, which inhibits the catabolism of citrate. After 30 days on the Ca diet containing fluoroacetate, the Sr contents of compact and spongy bone were 20–30% higher than in the bone of rats not fed this metabolic inhibitor. (BBB)

38710 THE PREPARATION OF H^3-VITAMINS D_2 AND D_3 AND THEIR LOCALIZATION IN THE RAT. Anthony W. Norman and Hector F. DeLuca (Univ. of Wisconsin, Madison). Biochemistry, 2: 1160-8(Sept.-Oct. 1963).

A convenient procedure for the preparation of tritium-labeled vitamin D_2 and D_3 is described. The provitamins were exposed to tritium gas by the procedure of Wilzbach, irradiated with ultraviolet light, and isolated as the crystalline 3,5-dinitrobenzoates. The H^3-vitamin D_2, specific activity 3.2 mC/mmole, or 450 disintegrations per minute per IU, and H^3-vitamin D_3, specific activity 7.2 mC/mmole or 1050 dpm/IU, are fully biologically active and were shown to be radiochemically pure in at least three chromatographic systems. The distribution of a physiological dose of H^3-vitamin D_3 as a function of time has been studied in the various tissues of the rat. Evidence is presented for the involvement of the ileum in the absorption of vitamin D. The liver rapidly accumulated the largest amount of radioactivity whether the dose was administered orally or intracardially. No evidence was found for the involvement of the adrenals in the metabolism of vitamin D. (auth)

38711 DEMONSTRATION OF A SECOND THYROIDAL IODIDE POOL IN RAT THYROID GLANDS BY DOUBLE ISOTOPE LABELING. Shigenobu Nagataki and Sidney H. Ingbar (Boston City Hospital and Harvard Univ., Boston). Endocrinology, 73: 479-87(Oct. 1963).

Rats were brought to specific activity equilibrium by repeated daily injections of a mixture of I^{127} and I^{131}. The animals were then given a blocking dose of propylthiouracil, followed by inorganic I^{132}, and were killed 1 hr later. From the plasma concentration of inorganic I^{131} and thyroid/plasma iodide concentration ratios for I^{132}, the expected thyroidal content of inorganic I^{131} was calculated. Invariably, direct measurement revealed far more inorganic I^{131} in the thyroid than could be accounted for in the external iodide pool, i.e., that pool of iodide in rapid equilibrium with iodide in the plasma, as measured by I^{132}. Thus, a second, or internal, iodide pool is postulated to exist. Evidence is presented which indicates that iodide in the internal pool arises from the deiodination of organic moieties by physiologic, rather than artifactual, means, and that it is not in rapid equilibrium with iodide in the external pool, since it is not discharged by thiocyanate, perchlorate, or large doses of iodide. Triiodothyronine decreases and acute doses of TSH increase the concentration of iodide in the internal iodide pool. (auth)

38712 EFFECT OF HYPOPHYSECTOMY OF THE PREGNANT RAT ON I^{131} METABOLISM OF THE PETAL THYROID GLAND. B. M. Nataf and I. L. Chaikoff (Univ. of California, Berkeley). Endocrinology, 73: 518-21(Oct. 1963).

Pregnant rats were hypophysectomized on the 12th to 13th days of pregnancy and killed 8 to 9 days later. Seventeen to 18 hr before they were killed, carrier-free I^{131} was injected either into the mothers or directly into the fetuses in utero. Hypophysectomy of the mother failed to influence fetal thyroid weight and had no significant influence on I^{131} uptake by the fetal thyroid gland; nor did hypophysectomy of the mother change the pattern of distribution of I^{131} among iodinated amino acids liberated by thyroglobulin hydrolysis of the fetal thyroid glands. These findings support the view that the hypophysial-thyroid axis functions in the rat before birth and that the deficiency of thyrotropic hormone induced in the mother by hypophysectomy does not affect the I^{131} metabolism of the fetal thyroid gland. I^{131} metabolism in the thyroid glands of hypophysectomized pregnant and hypophysectomized nonpregnant rats was compared. In the pregnant rats, I^{131} uptakes were higher, and labeling of thyroidal thyroxine was higher and that of monoiodotyrosine lower than in corresponding nonpregnant rats. (auth)

38713 CLINICAL USE OF I^{125} IN KIDNEY FUNCTION TESTING. Chester C. Winter and William G. Myers (Ohio State Univ., Columbus). Health Center J. (Columbus), 12: 8(1962).

Ten compounds tagged with three different radioisotopes were evaluated for testing kidney function. Among the compounds tested, Urokon labeled with I^{131} was found to be excreted too slowly; Diodrast-I^{131} proved to have limited usefulness because it is also excreted by the liver; Miokon-I^{131} and Renografin-I^{131} were found to be excreted too slowly by the kidneys, as were DISA-I^{131} (2,6-diiodosulfanilate with I^{131}) and EDTA-Cr^{51} (chelated complex between ethylenediaminetetraacetate and Cr^{51}). Hypaque-I^{131} and Hippuran-I^{131} currently are among the best test agents. Each is cleared rapidly from the blood by the kidneys alone. Hippuran (sodium ortho-iodohippurate) is the compound of choice because $^3/_4$ of it clears into the urine of normal patients 30 min after it is injected. Cr^{51} attached to EDTA, while having the desirable properties of lower radiation exposure, convenience, and economy, was found to be unsuitable for renal tests. In contrast, I^{125} is useful in renography. It emits x rays and γ rays with usable energies of 27.2 to 35.4 kev that have a broad beam half thickness in water and soft tissue of ~1 in. Its low-energy photons permit thin detector crystals to be used so that background counts are low and consequently dosages can be smaller. In addition, detectors can be much lighter and collimators less bulky than is necessary in the use of I^{131} (whose emissions include a 364-kev γ ray). A second renogram may be made immediately by covering the detector crystal with a 0.01-in. lead foil to absorb the soft I^{125} photons and administering a compound labeled with I^{131}, for example, Hippuran-I^{131}. As an alternative, a spectrometer may be used to tune out I^{125} photons in the presence of an emitter of higher energy photons. Hippuran-I^{125} was found to be the best test agent when used with detectors and circuitry that are best matched to exploit fully the superior physical properties of I^{125}. It reduces radiation exposure to the patient and affords a major simplification of equipment used in testing kidney function, and its longer shelf life of 60 days, compared with I^{131} (8 days), reduces the cost of the test agent. (BBB)

38714 THE EFFECT OF DIETARY PHOSPHORUS ON THE METABOLISM OF CALCIUM AND STRONTIUM IN THE RAT. K. Kostial (Inst. for Medical Research, Zagreb), A. Lutkić, N. Gruden, S. Vojvodić, and G. E. Harrison. Intern. J. Radiation Biol., 6: 431-9(May 1963). (In English)

An investigation was made of the way in which changes in dietary P within the physiological range influence the comparative metabolism of Ca and Sr in the rat. Radioactive Ca and Sr were used as tracers. The absorption of both Ca and Sr after oral administration was dependent on the P level in the diet, but not to the same degree. The skeletal ratio Sr^{85}/Ca^{47} decreased by some 40% as the dietary P was increased from 0.5 to 1.3%. After intraperitoneal injection of radioactive Ca and Sr, the skeletal retention of Sr^{85} was about 25% more on a diet containing 1.3% P than on a diet containing 0.5% P. Skeletal retention of Ca varied little. It is concluded that renal discrimination against Sr as well as intestinal absorption of Ca and Sr were affected by the P content of the diet, but in opposite directions. (auth)

38715 A NOTE ON QUANTITATIVE ASPECTS OF RADIOSTRONTIUM RETENTION BY MICE ON DIFFERENT DIETARY LEVELS OF PHOSPHORUS. R. H. Mole (Medical Research Council, Harwell, Berks, Eng.). Intern. J. Radiation Biol., 6: 499-500(May 1963). (In English)

Data from recent studies of Sr^{90} retention in mice on different dietary levels of P are reviewed. It is suggested that when long-term retention of Sr follows a power function, the magnitude of the exponent depends on the P content of the diet. (C.H.)

38716 ACCUMULATION OF RUBIDIUM-86 BY THE RABBIT LENS. Bernard Becker (Washington Univ., St. Louis). Invest. Ophthalmol., 1: 502-6(Aug. 1962).

In rabbit lenses incubated in vitro in potassium-free Tyrode's solution, accumulation of Rb^{86} remained linear for the initial 4 to 6 hr and in the K-free medium, a T/M (tissue/medium) ratio averaging 18 was found at 4 hr. In Tyrode's solution containing 3 meq K^+/l, the T/M ratio averaged 12 at 4 hr. Lenses from different animals varied in T/M ratio from 9 to 30 in a K^+-free medium, but the lenses of the two eyes from the same animal accumulated Rb^{86} at remarkably similar rates. A marked decrease (40%) in accumulation was noted when the medium was glucose-free. This was more marked when the medium was glucose- and K-free than when K was present. Galactose could replace glucose in the medium and restore normal T/M ratios. Accumulation of Rb^{86} was not altered by the absence of oxygen, provided glucose was present. In a Ca- and K-free medium, the accumulation was reduced to less than 20% of the Ca-containing control. Variations of pH between 6.5 and 8.0 failed to alter accumulation of Rb^{86}, but below 6.5 and above 8.0 it was decreased. Accumulation in K-free medium was not influenced by the addition of pitressin, insulin, glycine, deoxycorticosterone, acetazolamide, L-alanine, Na, lactate, choline, or Na ascorbate. The data of accumulation at various Rb concentrations could be fit approximately to a Lineweaver-Burk type plot. The apparent Michaelis-Menten constant, K_m (half-saturation concentration) approximated 2.3 mM Rb^+, and the max velocity was estimated at 42 mmole/kg lens water per 4 hr. At K concentrations of 4.5 mM the accumulation of trace amounts of Rb^{86} was reduced by 50%. Similar studies with NH_4 ion in a K-free medium suggested that NH_4 concentrations of ~12 mM inhibited the uptake of Rb^{86} by 50%. Various metabolic and other inhibitors decreased the capacity of the lens to accumulate Rb^{86}: iodoacetate, fluoride, cyanide, dinitrophenol, fluoroacetate, digoxin, and ouabain. It is concluded that the 4-hr uptake of Rb^{86} by lens incubated in a highly simplified medium provides a convenient and reproducible tool for studying cation transport in the lens. The results provided evidence for competitive inhibition by K and for the active transport of Rb into lens. The ac-

cumulation occurs against a concentration gradient, is temperature dependent, and is altered by competitive and metabolic inhibitors. (BBB)

38717 DISTRIBUTION OF RUBIDIUM-86 ACCUMULATED IN THE RABBIT LENS. Bernard Becker and Edward Cotlier (Washington Univ., St. Louis). Invest. Ophthalmol., 1: 642-5(Oct. 1962).

Serial frontal sections were made of rabbit lenses after incubation in vitro in a simplified medium containing Rb^{86}. The earliest accumulation and highest accumulation ratios of Rb^{86} were found in sections closest to the epithelium. In these anterior sections, values exceeded the medium concentration after 10-min incubation. The lowest concentrations were found deep in the nucleus of the lens. In the presence of ouabain (7×10^{-6} M) the accumulation of Rb^{86} showed a marked decrease (10 to 20% of normal) at all time intervals. The accumulation was particularly affected in areas closest to the lens epithelium. When the time course of accumulation was plotted for selected segments of the lens without ouabain, the accumulation in the area closest to epithelium was reasonably linear and very much more rapid than in areas farthest removed from epithelial structures. On the other hand, under the influence of ouabain inhibition of the transport process, interior sections were remarkably similar in Rb^{86} content. In a potassium-free medium the 50% inhibitory concentration of ouabain was 7×10^{-8} M, whereas in a medium containing 5 mM K^+ it was closer to 1×10^{-6} M. The most active areas demonstrate a sensitivity to ouabain inhibition which closely resembles that of the Na–K-activated ATPase of rabbit lens epithelium. (BBB)

38718 THE USE OF DEUTERIUM ISOTOPE EFFECTS FOR STUDIES OF DNA STRUCTURE AND FUNCTION. T. R. Henderson (Univ. of Arkansas, Little Rock). J. Arkansas Med. Soc., 59: 379-82(Mar. 1963).

The biological effects due to inhibition by D_2O are discussed. The evidence of a primary isotope effect on DNA is as follows: instantaneous inhibition of cell division and DNA synthesis when cells are transferred into D_2O; continued production of genetically defective sperm for a considerable period in deuterated male mice following return to regular drinking water, suggesting that D has made an impression on the information-bearing units; isolation of DNA in a modified form from deuterated animals; and the interference by D_2O with the genetically controlled synthesis of β-galactosidase in bacteria. The presence of D_2O greatly impairs the ability of the bacterial cell to respond to β-galactosides, but does not appreciably effect enzyme synthesis once it has been initiated. It is therefore postulated that the presence of heavy water modifies the functional state of DNA in vivo. A likely site of action may be on the keto-enol tautomerism of the purine and pyrimidine bases of DNA, since these equilibria result in rapid exchange of H (or D) with the medium. By an experimental study of this equilibrium, it was possible to calculate the percentate of keto form existing in solution at a particular pH or pD. The presence of D_2O shifts the equilibrium toward stabilization of the keto form when comparison is made at the same pH and pD. The apparent pK of 6-thioguanine is 8.2 in H_2O and 8.6 in D_2O. Similarly, the pK of guanine was found to be 9.2 in H_2O and 10.0 in D_2O. The pK of thymine did not vary appreciably (10.0 in H_2O; 10.4 in D_2O). Stabilization of the keto tautomer of guanine by D_2O would be a very small effect at physiological pH since with a pK of 9.2 it would be predominantly in the keto form. The small magnitude of these isotope effects makes it unlikely that they would be significant in the metabolism of nucleotides and polynucleotides except possibly in the case of high molecular wt polynucleotides such as DNA, where thousands of stacked, H-bonded bases are involved. An investigation of the properties of DNA in aqueous and deuterated solutions showed no appreciable differences in the denaturation of DNA brought about by formamide (no appreciable differences were previously detected in the heat denaturation profiles of DNA or other polynucleotides in water or heavy water). Renaturation experiments showed an increased degree of renaturation (7-15% in DNA from chicken erythrocytes) in the presence of D_2O. This suggests that heat denaturation may be incomplete in D_2O, and that the persistence of a few H-bonded regions, by maintaining the strands in register, may promote helix reformation. It is proposed that the factors which lead to breakdown of DNA guanine-cytosine H-bonds may be dependent in part on shifts in the keto-enol equilibrium, and impairment of this mechanism by D_2O may result in incomplete strand separation. To explain the inhibitory effects on regulation of enzyme synthesis, it is suggested that genetic control of enzyme synthesis involves changes in the pattern of folding or the degree of H-bonding of DNA at specific regions which are predominantly guanine or cytosine in base sequence. (BBB)

38719 EXCRETION OF P^{32} AFTER THERAPY FOR POLYCYTHEMIA RUBRA VERA. D. L. Weijer, H. E. Duggan, and D. B. Scott (University Hospital, Edmonton, Alberta, Can.). J. Can. Assoc. Radiologists, 13: 81-5 (Sept. 1962).

Fifteen subjects undergoing treatment for polycythemia rubra vera were given P^{32}. Carrier-free P^{32} was administered intravenously in 11 and orally in 6. Total excretion studies were carried out in each case for periods of 5 to 22 days. Average urinary excretion of P^{32}, as a percentage of the initial dose to the end of 3 days for the entire series, was 14.3%, with limits of 6.4 and 18.7%. The corresponding 5-day average amounted to 17.8%, with limits of 7.5 and 22.5%. In the six patients treated orally, the average 3-day urinary excretion was 11.2% and for 5 days was 14.2%. For the 11 patients treated intravenously, the average 3-day excretion was 16.1%, the average 5-day excretion 19.8%. The average fecal excretion as a percentage of the initial dose to the end of 3 days was 1.7%, with limits of 0.1 and 5.5%, and the average 5-day excretion was 2.5%, with limits 0.5 and 5.9%. In the orally treated fasting group the total stool excretion to the end of 3 days was 2.0 and 2.5% at the end of 5 days. Of the 10 polycythemia patients treated intravenously, the stool excretion to the end of 3 days was 1.5% and at 5 days 2.5%. Under fasting conditions (both before and after the administration of P^{32}) with little or no carrier added, the fecal excretion of P^{32} is small. Thus, the total excretion of P^{32} does not differ significantly for oral and intravenous administration. Hence, despite contrary reports, it appears that under fasting conditions of administration it is not necessary to increase the oral dose of P^{32} to 4/3 of the intravenous dose in order to obtain equivalent absorption of the administered dose. It is concluded that the P^{32} content of urine in the first 24 hr after therapy, by either route of administration, indicates whether or not a particular patient will retain the dose within normal limits. (BBB)

38720 BISMUTH NEPHROTOXICITY: REPORT OF A CASE. Joyce D. Gryboski and Samuel P. Gotoff (Yale Univ., New Haven). New Engl. J. Med., 265: 1289-91(Dec. 28, 1961).

A case of renal poisoning by bismuth thioglycolate is reported which demonstrates the nephrotoxicity of bismuth

compounds in the pediatric age group. For treatment of warts the patient received a relatively small amount of bismuth thioglycollate (1.3 mg/kg body wt), and although the symptomatology was mild, the degree of azotemia was severe. Evidence of both tubular and glomerular damage was present, the former reflected by fixed urinary specific gravity and minimal glycosuria in the presence of a normal blood sugar, and the latter by azotemia and mild proteinuria. Backward diffusion of creatinine through damaged tubular epithelium probably contributed to the observed elevated plasma creatinine value, and the presence of a high anion content of serum probably represented retained phosphate, sulfate, and organic acids. The observed maculopapular rash probably corresponded to the so-called erythema of the ninth day, described previously as a rare manifestation of bismuth toxicity. The therapy employed was that for acute renal failure, but chelating agents, which are potential nephrotoxins, were not employed because of the known rapid excretion of bismuth thioglycollate. Rehydration was carried out, and electrolyte and protein intake was limited until diuresis was well established and the blood urea nitrogen had begun to fall. To avoid hyperkalemia, potassium restriction was carried out. Normal renal function was restored within a month after the onset of renal injury. It is suggested that the degree of sensitivity to the metal was related to the age of the patient and to the structural maturity of the kidney, for all cases of bismuth nephropathy reported the past 15 yr have occurred in the pediatric age group, children less than 3 yr being the most severely affected. (BBB)

38721 RADIOACTIVE IODINE IN THE LYMPH LEAVING THE THYROID GLAND. R. M. Daniel, Muriel M. Gale, and O. E. Pratt (Maudsley Hospital, London). Quart. J. Exptl. Physiol., 48: 138-45(Apr. 1963).

Very high levels of I^{131} were found in lymph of vessels draining the thyroid gland of animals injected with the isotope. The lymph was collected from the draining lymphatics 2-6 days after subcutaneous injection of 50-100 μC in rabbits and cats and 200 μC in sheep. Thyroid lymph contained a concentration of radioactivity considerably higher than that in either thyroid venous plasma or systemic blood plasma. This was found in all three species both before and after giving thyroid-stimulating hormone (TSH). Almost all the radioactivity in the lymph was due to organic I^{131}. When the thyroid gland was excised postmortem, a count showed that the proportion of I^{131} which had been injected and which remained in the gland at the end of the experiment varied considerably. Estimates of the radiation dose varied between 30 and 200 rad. There was no obvious relation between this dose the lymph/plasma I^{131} ratio, which indicates that the radiation dose was not so high as to produce damage to the gland. The radiation dose to the thyroid in these experiments was not greater than is customarily given in studies of hormone release from the thyroid and the dosage used gives a lower level of radiation than that thought to cause radiation damage to the gland. Since, therefore, damage to the thyroid can be discounted as a cause for the release of iodinated protein, it seems likely that a significant proportion of organic iodine leaves the gland under normal conditions via the lymphatic pathway both before and after the administration of TSH and that this pathway should be taken into account in all studies of thyroid secretion. Gentle massage of the gland, which increases the flow of lymph, did not lead to an increase in the output of radioactivity. Movement of lymph in the thyroid vessels is relatively rapid and since the concentration of I^{131} in thyroid lymph is high, the amount of thyroid hormones leaving the gland by this pathway must be considerable. (BBB)

38722 THE DOUBLE PERFUSION TECHNIC IN THE STUDY OF THE ACTION OF STRONTIUM IONS ON CARDIAC ACTIVITY. L. Palagi, S. Sonnino, and E. Biagi (Università, Rome). Rass. Fisiopatol. Clin. Terap., 33: 676-82 (Aug. 1961). (In Italian)

Differences between the actions of Sr^{2+} and Ca^{2+} on the rabbit heart were detected by a double perfusion technic. Perfusion of the isolated heart with Locke solution containing 0.2% $SrCl_2$ produced marked changes in ventricular electrical and mechanical activity. As shown by the electrocardiogram, initially systole is prolonged, with elongation of the ST segment and increase in height of the T wave. The amplitude of contraction, thus initially heightened, is then depressed, terminating in partial or total block of ventricular activity. In contrast to Ca which selectively blocks atrioventricular conduction, it was concluded that Sr acts primarily on terminal conduction. (BBB)

38723 THE INCORPORATION OF RADIOACTIVE PHOSPHORUS BY STRUCTURES OF THE HUMAN OVARY. A. Zacutti and G. Turchetti (Università, Pisa, Italy). Riv. Ostet. Ginecol., 16: 233-43(Apr. 1961). (In Italian)

The possibility that P^{32} treatment of women of childbearing age may cause selective irradiation of follicular elements, and thus cause genetic damage, was investigated by radioautographic examination of the ovaries of women removed 48 hr after intravenous injection of 2 μC P^{32} per kg body wt. The relation of the amount of P^{32} incorporated by various structures to the phases of the ovarian cycle was studied in particular. No uptake by the primordial follicles was noted. The granulosa cells of the maturing follicle showed a moderate uptake and those in the ripe follicle a marked uptake. Minor radioactivity was seen in the thecae interna and externa of ripe follicles, and little was present in atretic follicles. Uptake by corpora lutea and by the interstitial tissue was also low. However, on the basis of the appreciable incorporation of P^{32}, presumably in the nucleic acids of granulosa cells, in the proximity of the developing ovocyte, it was concluded that there is substantial risk of genetic injury to the ovum in women receiving this isotope. (BBB)

38724 EFFECT OF PLACEMENT ON THE ABSORPTION OF Rb^{86} AND P^{32} FROM SOIL BY CORN ROOTS. E. H. Vasey and Stanley A. Barber (Purdue Univ., Lafayette, Ind.). Soil Sci. Soc. Am. Proc., 27: 193-7(Mar.-Apr. 1963).

Placement of Rb^{86} and P^{32} in the soil affected their relative uptake by corn roots. Autoradiographic techniques were used to determine the uptake processes involved. Banding of the fertilizer rather than mixing with the soil affected Rb^{86} uptake more than P^{32} uptake. The diffusion rate for Rb^{86} in the soil was much larger than for P^{32}. Also, Rb^{86} was translocated more extensively throughout the corn root than was P^{32}. The greater uptake of Rb^{86} from band applications appeared to be due to both a greater facility for uptake by a small portion of the root and a greater diffusion of Rb^{86} out of the band. (auth)

38725 ROOT TRANSFER OF FISSION PRODUCTS FROM CONTAMINATED SOIL. E. M. Romney, H. Nishita, J. H. Olafson, and K. H. Larson (Univ. of California, Los Angeles). Soil Sci. Soc. Am. Proc., 27: 383-5(July-Aug. 1963).

Dry yield of wheat grown for 117 days was not affected by solutions of nuclear reactor-produced mixed fission products (MFP) applied to the soil surface or mixed with

equal amounts of potted soil at contamination level ranging from 0.01 to 1.0 μC beta activity per g of soil. Concentrations of beta and gamma activity in the above-ground parts of plants were increased as the soil contamination levels increased. Wheat removed from 0.07 to 0.09% of the total beta activity that had been mixed with the soil and from 0.10 to 0.15% of that which had been applied to the soil surface. Concentrations of radioactivity in above-ground plant parts were highest in leaves, intermediate in stems and lowest in fruiting heads. Radiostrontium accounted for 50 to 80% of the beta activity transferred to above-ground plant parts; <10% was attributable to root transfer of Y^{91}, Ru^{106}, Cs^{137}, and Ce^{144} from soil. (auth)

38726 STRONTIUM-90 IN HUMAN TEETH. PART II. Rudolf Keil, Friedrich Randow, and Hans-Arthur Schulze (Universität, Rostock, Ger.). Strahlentherapie, 122: 117-22(Sept. 1963). (In German)

The determination of Sr^{90} in human teeth of different ages is reported. A decrease of the Sr^{90} contamination beginning with the 2nd decade of life was observed in skeletal bone as well as in teeth. The contamination rates of the milk teeth were 0.44 for the year 1961 and 0.46 for the first half of 1962 (mostly 7- to 9-yr-old children). The contamination rates of the permanent teeth of children up to 18 yr were 0.49 and 0.36, respectively; it was 0.13 and 0.14 for the teeth of adults between 18 and 30 yr and 0.10 and 0.05 pC Sr^{90}/g Ca for adults over 30 yr. A standard tooth with 1 g ash content and 0.18 pC Sr^{90} (0.5 pC/g Ca) contains about 8 million Sr^{90} atoms; its activity is about 25 nuclear transformations/hr or about 200,000/yr. These are numbers which are doubled in case of equilibrium with Y^{90} (about 2000 atoms). (auth)

38727 ON THE INFLUENCE OF CARRIER ADDITIONS ON THE INHALATION EXPERIMENTS WITH $Y^{91}Cl_3$. Ingeborg Schmidtke, Walter Schiessle, and Kurt Philipp (Medizinische Universitätsklinik, Freiburg i. B.). Strahlentherapie, 122: 123-36(Sept. 1963). (In German)

In a continuation of previous studies concerning the inhalation of carrier-free $Y^{91}Cl_3$ the influence of additional inactive carrier upon the distribution and excretion pattern was studied over a period of 8 weeks using 24 guinea pigs for the experiments. In spite of a 10^6-fold increase of Y, the distribution pattern differs only slightly from the one obtained after inhalation of a carrier-free solution. This does not agree with the investigation results obtained after intravenous injection, but it agrees with the results obtained after intramuscular and intraperitoneal injection of larger amounts of Y. (auth)

38728 TREATMENT FOR INTERNAL CONTAMINATION WITH RADIOACTIVE SUBSTANCES. W. J. Carpaij (Philips Gezondheidscentrum, Eindhoven, Netherlands). Tijdschr. Sociale Geneesk., 41: 3-7(Jan. 4, 1963). (In Dutch)

Methods, such as use of chelating agents, for removing ingested radioisotopes from the body are reviewed. (BBB)

38729 THE DISTRIBUTION OF INTRAVENOUSLY ADMINISTERED YTTRIUM CHLORIDE (CARRIER FREE) IN THE RHESUS MONKEY. Ernest A. Diagneault (Louisiana State Univ., New Orleans). Toxicol. Appl. Pharmacol., 5: 331-43(May 1963).

The biologic handling of Y is of some importance since Y^{90} is being used increasingly in radiotherapy. Thus a study was made of the distribution of Y after intravenous administration of carrier-free $Y^{91}Cl_3$ in the rhesus monkey to compare the results with those obtained in other species. The response of zymosan-pretreated monkeys to intravenous Y was also studied. Y in the blood is cleared rapidly; its half life is 10 min. After injection of 80 μC/kg, highest concentration of Y occurs in femur, liver, intestine, kidney, and skull bone. Less active but with values exceeding that of blood at the time of sacrifice are lung, adrenal, spleen, thyroid, and heart, with practically no Y in brain and thymus. A comparison of the rat and mouse data with data of the monkey shows they are closely parallel, except that the mouse differs by exhibiting a high lung and spleen concentration. The excretion of Y during a 4-hour interval shows that a substantial amount is excreted in urine and a small amount in the bile. Feces did not contain any measurable activity during this interval. In rat and mouse the predominant excretion is also via the urine. Intravenous administration of zymosan, 25 mg/kg 3 days prior to administration of Y, produced no enhancement of the blood clearance. The observed half life value of 12.0 min was not significantly different from the control value. Y tissue distribution was not affected by the more active reticuloendothelial system; the active ratio in the liver actually decreased. Mice and rats, however, did respond to zymosan with the expected enhanced concentration of Y in the liver and spleen. Excretion of Y by the pretreated monkeys was not depressed. The other two species which did respond to zymosan treatment excreted less Y than the control, as expected. In accord with the results of tissue analysis, study of the gross autoradiograms revealed no difference between the treated and nontreated. Cross-section of the femur shaft showed that the marrow had no significant activity, and activity that was present was located in the periosteum. Distribution in the liver and spleen was generalized whereas in the lung, kidney, adrenal, and femur it was more selective. The brain was devoid of Y. The rat tissue autoradiograms showed similar results. Lack of activity in the brain indicates that Y is unable to penetrate the blood brain barrier. The pattern of deposition of Y in the rhesus monkey agrees well with that reported for the rabbit, guinea pig, and man, and show a closer similarity to the rat than the mouse. (BBB)

38730 BERYLLIUM DISEASE: A CONTINUING DIAGNOSTIC PROBLEM. Harriet L. Hardy (Massachusetts Inst. of Tech., Cambridge). Trans. Assoc. Am. Physicians, 74: 333-41(1961).

Problems encountered in the diagnosis of chronic Be intoxication are discussed with reference to three cases in particular and to a survey of 650 other cases. Its diagnosis may be difficult because its clinical character is very like other diseases, notably sarcoidosis and miliary tuberculosis, plus the vast array of diseases presenting miliary densities on chest x-ray with and without such non-specific symptoms as dyspnea and cough. In addition, there may be a delay in onset between illness and the last exposure to toxic Be compounds varying in time to as long as 5 to 10 yr and in a few cases longer. Chronic Be disease presents a wide spectrum of clinical pictures. A few patients, followed for several years, continue to show only bilateral chest x-ray changes, while others with mild to moderate disability, complaining of cough, dyspnea, and weakness, have varying degrees of diffusion defect with resulting oxygen unsaturation. Others, completely disabled with obvious serious lung destruction, enlargement of liver and spleen, and stone formation, go through bouts of fever, and remain dependent on steroids and oxygen therapy for existence. This chronic poisoning is a disease of long course with remissions and exacerbations. The three cited cases illustrate that diagnosis rests primarily on establishing exposure to toxic Be compounds. A Be patch test is an aid to diagno-

sis, but there is no agreement that a negative test rules out Be poisoning. In addition, there is some evidence that use of such a test may exacerbate the toxic Be effect. Differential diagnosis between Be disease and sarcoidosis, the most difficult diagnostic problem, rests on the establishment of Be exposure. (BBB)

38731 ELECTRON MICROSCOPIC OBSERVATIONS ON ABSORPTION IN THE EPITHELIUM OF THE GUINEA PIG GALL BLADDER. A. F. Hayward (Glasgow Univ.). Z. Zellforsch., 56: 197-202(1962). (In English)

The mechanism of absorption of ThO_2 particles (Thorotrast) by gall bladder epithelium was studied by taking advantage of the high electron density of the particles. Thirty min after injection into the lumen of guinea pigs, ThO_2 particles were seen adhering to the apical cell surface and to the inner surface of small cytoplasmic vesicles just below the apex. The appearance suggests that the absorption occurs by pinocytosis. Two hr after the injection, ThO_2 particles were widespread throughout many of the epithelial cells, and in addition to their presence in superficial vesicles, free particles were found in the lumen of vacuoles deeper in the cytoplasm. Dense cytoplasmic bodies could be seen near the Golgi apparatus and nucleus. Except for the presence of Thorotrast, the dense bodies resembled those of untreated gall bladder epithelium. Thorotrast particles were also found between adjacent epithelial cells, not only where there is a dilated intercellular space but also where the lateral cell membranes are closely apposed. No particles were seen in the terminal bar area or elsewhere outside the epithelial cells. The Thorotrast ingested by epithelial cells is apparently dealt with in one of two ways. It may be discharged into the intercellular spaces in the same way as fat in the small intestine. Alternatively, Thorotrast remains within the cell in the dense cytoplasmic bodies probably resulting from fusion of the pinocytotic vesicles and partial extraction of their contents. The dense bodies of the gall bladder epithelium resemble those of other epithelia, including the absorptive epithelium of small intestine and tracheal mucosa. Similar bodies seen in macrophages might be the end-product of phagocytosis of ThO_2. (BBB)

Fallout and Ecology

Refer also to abstracts 38705, 39299, 39323, and 39347.

38732 (NP-13115) FALLOUT NUCLIDE SOLUBILITY, FOLIAGE CONTAMINATION, AND PLANT PART UPTAKE CONTOUR RATIOS. Carl F. Miller (Stanford Research Inst., Menlo Park, Calif.). July 1963. 33p.

Mathematical formulations for fallout nuclide solubility, foliage contamination, and plant part uptake contour ratios are presented for estimating the degree to which various radionuclides in fallout enter the food chains. The nuclide solubility is determined, for the fallout from a land-surface detonation, mainly by the properties of the soil carrier material at the point of detonation and other conditions of detonation. The major parameters which determine foliage contamination are the size of the deposited particles, the foliage surface density, and the fallout deposit level. The type of leaf surface and its orientation are also factors, but the available data are not adequate to resolve the effect of these two factors on the direct contamination of foliage. Very few data are available on the change in foliar contamination with plant size or age for animal crops. The plant part uptake occurs by both foliar assimilation or absorption and assimilation through plant roots (for fallout mixed in the soil). Data on foliar assimilation from solid particles deposited on plant foliage and fruits have not been reported. The reported data are from contamination by liquid sprays in laboratory experiments and, indirectly, from world-wide fallout that is deposited mainly in the form of rain drops. Essentially no data are available for making quantitative estimates of food crop contamination by foliar absorption for nuclides in fallout from land-surface detonations. Leaching by rain or washing, the degree of movement of nuclides through the plant, and various plant characteristics are factors which influence the degree of contamination of edible plant parts. The major parameters for uptake in plant parts from the soil are the soluble and available nuclide concentrations in the soil, the plant part surface density, the distribution among the different plant parts, and the type of soil. From the available data, the radioelement having the highest soil uptake contamination factor is Sr^{90}, the highest values found for the factor are generally for plant leaves and the lowest values are usually for grains or seeds and fruits. (auth)

38733 HUMAN BODY BURDEN CAUSED BY DIET Cs^{137}. H. Siedler, M. Haertig, and K. Siebert (Inst. of Nourishment, German Academy of Sciences, Potsdam-Rehbrucke, Ger.). Kernenergie, 6: 436-40(Aug. 1963). (In German)

The distribution and behavior of the Cs^{137} originating from nuclear weapon explosions are explained and the values reported in the literature of its biological or effective half life as well as its activity in milk, meat, and in man are given. For determination of the Cs^{137} activity of the total food, cesium was isolated by a combination of methods and counted in an integrating single-channel gamma spectrometer. The annual average for 1961 amounted to ≈75 pc/gK or 150 pc/day for adults and ≈60 pc/gK or 75 pc/day for small children and infants. (tr-auth)

38734 RADIOACTIVITY LEVELS FOUND IN SOME SPECIMENS OF NON-MIGRATORY AND MIGRATORY BIRDS. M. Zanetti and F. Cutrufelli (Università, Bologna). p.7-11 of "Third International Congress on Hygiene and Preventive Medicine, Vienna, May 27-30, 1962."

The radioactivity of some birds, having summer nesting habitats in northern USSR in proximity of nuclear weapons test sites and having Mediterranean winter habitats, was examined. These birds passed over Italy during the 1961-2 fall-winter southward migration. The following migratory birds specimens were examined: woodcock (Scolopax rusticola) and fieldfare (Turdus pilaris); and for comparison some specimens of nonmigratory birds, i.e., Willow Ptarmigan (Lagopus lagopus), seized in the USSR, and domestic pigeons (Columbus livia), seized in Bologna. The birds were plucked and completely incinerated. Spectrographic analysis of the ashes of both pigeons and fieldfares, carried out to determine the elements present therein, showed no qualitative differences. The following elements were present: appreciable quantities of Na, Mg, Si, P, K, Ca; traces of Al, Mn, Fe, Ba; slight traces of Li, Cu, Rb, Sr, Sn, Pb. Total β counting of the ashes showed in pigeons a lack of artificial radionuclides and a low radiostrontium concentration. Total β activities, as well as those due to Sr^{89} and Sr^{90} found in the different woodcock specimens show rather large variations: values ranging from 404 to 1871 pC/kg for Sr^{89} and 99.7 to 748 pC/kg for Sr^{90}. The Willow Ptarmigan showed a rather high radiostrontium concentration (1530 pC/kg) and fieldfares had both a high

radiostrontium activity (1676 pC/kg) as well as a high total β activity (8042 pC/kg). Measurements taken at various periods in fieldfares showed considerable variation (8042 pC/kg on December 11, 1961; 6209 on December 27, 1961; and 4899 on January 11, 1962. If the radiostrontium values are subtracted from the total β values, the resulting level shows a 50% fall over one month, indicating the presence of radionuclides with relatively short decay periods. The results suggest radionuclide pollution of the northern nesting grounds of the migrating birds. (BBB)

Radiation Effects on Living Tissues

Refer also to abstracts 39349, 39350, 39352, and 39353.

38735 (AD-296592) THE EXTENSION OF STORAGE LIFE OF FRESH FRUIT AND VEGETABLES BY IONIZING RADIATION. Report No. 9 (Final), June 27, 1957–June 26, 1961. Dudley C. Martin (Kentucky. Univ., Lexington). Contract QMR&E (NATICK) No. 87. 70p.

Results are reported from an evaluation of the effects of radiation processing on the quality and storage life of cauliflower, broccoli, and strawberries after storage at temperatures slightly above freezing for periods up to 12 months. Irradiation was effective in preventing visible spoilage, even at a dose of 0.3 Mrad. Acceptability of samples stored at 35°F declined with each succeeding evaluation. (C.H.)

38736 (AD-296953) REVIEW OF THE UNITED STATES ARMY'S IRRADIATED FOOD WHOLESOMENESS PROGRAM. Report No. 268. M. E. McDowell and N. Raica, Jr. (Army Medical Research and Nutrition Lab., Denver). May 29, 1962. 39p.

The wholesomeness of food involves nutritive value and toxic effects. Results are reviewed from studies conducted over a 2-yr period on the effects of radiation processing on the wholesomeness of foods incorporated into the diets of rats and dogs. It was concluded that any adverse effects resulting from feeding irradiated foods are the result of nutrient alterations such as occur in other processing procedures. (C.H.)

38737 (AED-C-12-04-I) AUSGEWAHLTES SCHRIFTTUM NACH SACHGEBIETEN. OSTLITERATUR DER KERNWISSENSCHAFTEN. STRAHLENWIRKUNG IN BIOLOGIE UND MEDIZIN. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected Literature According to Subject Field. Literature of the East on Nuclear Sciences. Radiation Effects in Biology and Medicine. Bibliographic Compilation). Benno Ensslen and Rolf Paul, comps. (Kernforschungsanlage, Jülich, Germany). Feb. 25, 1963. 231p.

References (1111) are given to U. S. and foreign journals and reports published from 1957 to 1962. Separate author and report number indexes are included in part II. (P.C.H.)

38738 (AED-C-12-04-II) AUSGEWAHLTES SCHRIFTTUM NACH SCHGEBIETEN. OSTLITERATUR DER KERNWISSENSCHAFTEN. STRAHLENWIRKUNG IN BIOLOGIE UND MEDIZIN. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected Literature According to Subject Field. Literature of the East on Nuclear Sciences. Radiation Effects in Biology and Medicine. Bibliographic Compilation). Benno Ensslen and Rolf Paul, comps. (Kernforschungsanlage, Jülich, Germany). 1963. 236p.

References (931) are given to U. S. and foreign journals and reports published from 1957 to 1962. Separate author and report number indexes are included. (P.C.H.)

38739 (BNL-766) THE ROLE OF THE CELL NUCLEUS IN DETERMINING RADIOSENSITIVITY. Brookhaven Lecture Series No. 17. Arnold H. Sparrow (Brookhaven National Lab., Upton, N. Y.). May 16, 1962. Contract AT-30-2-GEN-16. 32p. (BNL-T-287)

Results are summarized from recent studies of factors that affect the radiosensitivity of plant cells. Young plants of many different species were exposed to acute or chronic x or γ radiation at a variety of exposure rates. Radiation damage was assayed by observations of chromosome breakage, somatic mutation, growth inhibition, or lethality. Clear relations were demonstrated between the average nuclear volume of meristematic cells and radiosensitivity of many diploid plant species. The larger the nucleus, the greater was the effect per r of exposure. The average size of the nucleus of a species was also positively correlated with the average DNA content per diploid cell. Radiosensitivity was found to be more closely associated with average DNA content per chromosome than with DNA per nucleus when species were compared that had a significant range in chromosome number. Other variables that may modify the relation between size and sensitivity are discussed. Data indicate that the number of sets of chromosomes, the degree of ploidy, and the average length of the nuclear cycle affect radiosensitivity. Gymnosperms were found to be much more sensitive to radiation than dicotyledonous angiosperms. (C.H.)

38740 (BNL-6709) SECONDARY TETANUS ANTITOXIN RESPONSES IN MICE ELICITED PRIOR TO IRRADIATION. William M. Hale (Tennessee. Univ., Memphis. School of Basic Medical Sciences) and Richard D. Stoner (Brookhaven National Lab., Upton, N. Y.). Feb. 5, 1963. Contract AT-30-2-GEN-16. 31p.

Secondary tetanus antitoxin responses were abolished in mice when sublethal radiation doses of 650 rads were delivered by short-term exposure 3 hr before the second injection of antigen. Nearly normal secondary responses were observed when the same radiation doses were delivered 4 days after antigenic stimulation, and sera were obtained 6 days later. Radiosensitivity of the seemingly radioresistant secondary antibody responses was demonstrated by ultimate repression of antitoxin titers when radiation was delivered 4 days after antigenic stimulation and sera were obtained 4 weeks after irradiation (32 days after the second injection of toxoid). It was possible to differentiate clearly between the capacity of these irradiated animals to produce nearly normal secondary responses and failure of the same animals to respond to a third antigenic stimulus when radiation was delivered 4 days after the second stimulus, and a third injection of antigen was given 30 min after the single exposure to 650 rads. A marked incorporation of tritium activity appeared in antitoxin produced during secondary responses of irradiated and nonirradiated mice when tritium-labeled L-histidine was injected on days 4 and 5 and on days 6 and 7 after the second stimulus of tetanus toxoid. The data indicate that the antibody produced during secondary responses in irradiated and nonirradiated mice was not performed during the induction phase and merely released on days 4 or 5, following the second stimulus of antigen. These findings indicate the presence of antibody-producing cells or their precursors that have proliferated in response to the second antigenic stimulus and survived long enough after irradiation to produce nearly normal secondary tetanus antitoxin responses. (auth)

38741 (BNL-6793) EFFECTS OF LOW LEVELS OF X-RAYS AND IRRADIATION FROM C^{14} AND H^3 ON CELL POPULATION KINETICS IN THE ROOT TIP OF TRADESCANTIA. Donald E. Wimber (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 18p.

Reciprocal labeling of cells of Tradescantia roots in double-labeling experiments with H^3- and C^{14}-thymidine showed that when H^3-thymidine (1 μC/ml for 0.5 hr) was given first in the labeling sequence followed by a 4-hr interval before the C^{14}-thymidine treatment, that passage of cells into and out of DNA synthesis was normal. When C^{14} was first in the sequence, the rate at which cells entered DNA synthesis was decreased. This was attributed to a radiation effect produced by the β rays from the C^{14}. The rate at which cells entered DNA synthesis was studied after 0.1, 1, and 10 rads of x rays. A dose of 1 and 10 rads decidedly depressed the rate. Treatment of roots with 2, 20, and 200 μC/ml of tritiated water for 0.5 hr showed that the 2 higher concentrations produced an effect similar to the x rays. This indicates that somewhere between 1 and 8 disintegrations/cell/0.5 hr produces a decrease in the rate at which cells enter DNA synthesis. In both the x-ray and H_2^3O experiments, the depression of the rate that cells entered DNA synthesis seemed to reach saturation at the higher doses. (auth)

38742 (NYO-10602) RELATION OF GAMMA IRRADIATION TO S^{35}, Se^{75} AND Ca^{45} MINERALIZATION. Final Report. (West Virginia. Univ., Morgantown). [1962]. Contract AT(30-1)-2766. 14p.

The results reported are from experiments designed to show the influence of gamma radiation on mineral metabolism using the radionuclides S^{35}, Se^{75}, Ca^{45}, and Cs^{134}. A study of the destruction or damage to the digestive absorptive epithelial tissue suggests that the apparent increased retention of S^{35}, Se^{75}, Ca^{45}, and Cs^{134} was not necessarily a true metabolic retention but the active absorption of the digestive epithelial allows a more rapid absorption of the radionuclides at one time, hence a greater concentration in the blood stream (less body dilution) and therefore resulting in greater molecular exchange of the radionuclide with the stable element. This in turn would give a false metabolic appearance. Although not emphasized, the data using different dose rates with rats show that there is a dose rate influence and that when rats are radiated at about 200 r/hr most of them can tolerate 1600 r and survive for 30 days or longer. The digestive epithelial tissue was damaged but healed in about 5 days. Rats held for 12 weeks past 1600 r radiation had highly enlarged intestines but the spleen which showed a great reduction 40 hours past radiation appeared normal in size. (auth)

38743 (SAM-TDR-63-13) INACTIVATION OF ENCYSTING AZOTOBACTER CELLS BY IONIZING RADIATION. Preliminary Report. Thomas L. Roberts (School of Aerospace Medicine, Brooks AFB, Tex.). May 1963. 4p. (AD-415022)

Azotobacter cysts were exposed to x, γ, and proton radiation. Results indicate a sensitive response to low levels of radiations. Azotobacter cysts may offer a biologic system for dosimetry of ionizing radiations. (auth)

38744 (TID-19410) THE EFFECT OF X-RAY IRRADIATION ON THE LIPIDS OF THE SKIN. Progress Report, October 1, 1962–June 30, 1963. Henry P. Schwarz (Philadelphia General Hospital). Contract AT(30-1)-1864. 16p.

Progress is reported in studies on the effect of whole-body x irradiation on phospholipids of rat liver mitochondria. The in vivo incorporation of P^{32} into phospholipids of lipid mitochondria was measured in irradiated and non-irradiated rats. Methods are described for the fractionation and analysis of solubilized liver mitochondria. Results show that x irradiation induces an increase of total lipid phosphorus of rat liver mitochondria and an increase in incorporation of P^{32} into mitochondrial phospholipids. (C.H.)

38745 (TID-19427) EFFECT OF GAMMA RADIATION ON BIOLOGICAL PROPERTIES RELATED TO STRUCTURE OF ANIMAL VIRUSES. Final Report. [Period Covered]: May 15, 1960–June 30, 1963. (Iowa State Univ. of Science and Tech., Ames. Veterinary Medical Research Inst. and Iowa State Univ. of Science and Tech., Ames. Inst. for Atomic Research). Contract AT(11-1)-902. 27p.

Progress is reported in studies of the nature of virus components and structures responsible for the observable differences in biological and serological properties of selected strains of Newcastle disease virus (NDV). Emphasis was placed on a study of genetic control of thermostabilities of different NDV strains, response to thermal and γ radiation stress of infective properties, hemolytic properties, and thermostability of various NDV strains. A schematic picture of virus structure is presented that is based on the experimental data. (C.H.)

38746 (TID-19432) INVESTIGATIONS ON MUTABILITY OF POLYGENES AND ON UTILIZATION OF INDUCED GENETIC VARIABILITY. Summary of the Results up to June 30, 1963 (Nine Months of the Second Renewal). R. E. Scossiroli (Pavia, Italy. Universita. Istituto di Genetica). July 1, 1963. Contract IAEA 61/US. 34p.

Results are reported from studies of radioinduced mutations in maize, wheats, tomatoes, and alfalfa. Observations on induced genetic variability for quantitative traits are presented. Data are also included from a genetic analysis of long- and short-winged lines of Habrobracon juglandis after 15 generations of inbreeding. (C.H.)

38747 (UR-610) A SELECTIVE BIBLIOGRAPHY ON THE ENDOCRINE RESPONSE TO IONIZING RADIATION. Frank M. Ganis, Thomas D. Brown, Carl L. Hansen, Jr., and Joe W. Howland, comps. (Rochester, N. Y. Univ. Atomic Energy Project). Oct. 10, 1963. Contract W-7405-eng-49. 366p.

Pertinent references current to Jan. 1962 are presented on endocrine response to ionizing radiation. The subject matter is arranged according to endocrine organ. Tracer studies were not included unless it was clear that the isotope used exerted a physiological effect in itself. (C.H.)

38748 (USNRDL-TR-666) THE PROTECTIVE EFFECT OF DEEP BODY HYPOTHERMIA ON X-RAY INDUCED MITOTIC ABERRATIONS OF REGENERATING RAT LIVER. M. J. Ashwood-Smith and G. F. Leong (Naval Radiological Defense Lab., San Francisco). 1963. 22p. (AD-417837)

The protective effect of hypothermia against x ray induced mitotic aberrations of regenerating rat liver was studied. The mitotic index of control and irradiated animals was but little affected by the hypothermic treatment, whereas the effect of x rays on retarding growth (body weight) was reduced considerably by hypothermia. Furthermore, the number of x-ray-induced mitotic aberrations in regenerating rat liver of hypothermic irradiated rats was reduced to the control values. It was concluded that this latter effect was probable owing to the extreme anoxic state rather than the concomitant hypothermia. (auth)

38749 (USNRDL-TR-668) INDUCTION OF HOMOGRAFT TOLERANCE IN SUBLETHALLY X-IRRADIATED ADULT MICE. W. E. Davis and L. J. Cole (Naval Radiological Defense Lab., San Francisco). Aug. 19, 1963. 15p.

It is now established that long-lived radiation chimeras, produced after the exposure of mice to lethal whole-body x radiation and infusion of allogeneic bone marrow cells are specifically tolerant to donor-type skin homografts. However, these tolerant mice represent the minority of animals thus treated which survive the secondary disease syndrome. The objective, therefore, has been to attempt to achieve homograft tolerance in sublethally irradiated adult mice under conditions that avoid secondary disease. Allogeneic mice which share the same H-2 locus, but differ at other histocompatibility loci, have now been used with some success. A tolerant state has been produced in CBA ($H\text{-}2^K$) mice by first exposing them to sublethal x radiation (500 rad) or urethan treatment coupled with irradiation, and then injecting C3H ($H\text{-}2^K$) spleen (18×10^6) and/or bone marrow (42×10^6) cells within 3 days post irradiation. These mice have retained subsequent C3H skin homografts (over 165 days) but have rejected BALB/c skin grafts ($H\text{-}2^d$) within 33 days. On the other hand, irradiated and urethan-treated controls, uninjected or injected with x ray inactivated (2000 rad in vitro) C3H cells, rejected both C3H and BALB/c homografts by 70 days. Similar results, although less definitive, have been obtained using C3H ($H\text{-}2^k$) or BALB/c ($H\text{-}2^d$) as the recipient mice and CBA ($H\text{-}2^k$) or DBA/2 ($H\text{-}2^d$) mice, respectively, for the donor cells. Such procedures, however, have been unsuccessful in producing homograft tolerance between donor and host F_1 hybrid mice which have one H-2 histocompatibility locus in common but differ at the other, for example, CAF_1 ($H\text{-}2^{d*a}$) and LAF_1 ($H\text{-}2^{b*a}$). The significance of these results with regards to the requirement of cellular chimerism for the induction and maintenance of homograft tolerance is discussed. (auth)

38750 (JPRS-20375(p.5-8)) REACTION OF IRRADIATED PROTEIN RADICALS WITH ALKYLPHENOLS. I. I. Sapezhinskii (Sapezhinskiy), M. S. Postnikova, and N. M. Emanuel'. Translated from Dokl. Akad. Nauk SSSR, 148: 1207-9(1963). (OTS-63-31393(p.5-8))

Changes in the electron paramagnetic resonance of irradiated serum albumin were recorded after the addition of the free radical inhibitor, 2,6-di-tert-butyl-4-methylphenol and before and after the addition of glacial acetic acid. The results are in agreement with the known reactions of the inhibitor with peroxide radicals. (C.H.)

38751 ACTION OF A COMPLEX RADIATION FLUX ON ERYTHROCYTE PHOSPHOMONOESTERASE. L. M. Buruiana, El. Hadarag, A. Dema, and I. Dema (Facultatea de Medicină Veterinară and Institutul de Fizică Atomică, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Biochim., 4: 463-72(1961). (In Romanian)

To study the effect of radiation on the enzyme, erythrocytes were irradiated in the reactor of the Institute of Atomic Physics of the Romanian Academy of Sciences, Bucharest, in which the intensity of the various radiation components is: thermal neutrons $2.3 \times 10^7/cm^2/sec$, epithermal neutrons $7.1 \times 10^5/cm^2/sec$, fast neutrons $4.0 \times 10^7/cm^2/sec$, and γ radiation 0.06 r/sec. In general, irradiation lowered the enzyme activity of solutions of the enzyme from horse erythrocytes, this reduction depending on the duration of irradiation and the initial enzyme activity. Kinetics of the nonirradiated and irradiated enzyme with respect to its substrate, α-glycerophosphate, were studied at various temperatures and substrate concentrations, according to the formulations of Lineweaver and Burk and the Michaelis constant (K_m) was determined. The value of K_m was 0.0294 and 0.10 mole/l after 30 and 60 min irradiation, respectively, in contrast to 0.04 mole/l for the native enzyme. The corresponding hydrolysis rates at a substrate concentration of 0.50 g/100 ml were 0.036, 0.025, and 0.045, as g P per 100 ml erythrocytes at 37°C. Impairment of quality of the enzyme during irradiation was shown by the progressive increase in activation energy, which rose from 8955 cal/mole in native enzyme to 11500 and 11666 cal/mole in solutions of enzyme irradiated for 15 and 30 min, respectively. Although the above data apply to the equine enzyme only, similar changes in kinetics were observed following irradiation of the enzyme in bovine erythrocytes. (BBB)

38752 POLAROGRAPHIC AND ELECTROPHORETIC STUDIES ON THE EFFECT OF A NEUTRON FLUX ON SOLUTIONS OF SERUM PROTEINS. L. M. Buruiana, V. Pavlu, I. Dema, C. Diaconescu, and A. Dema (Facultatea de Medicină Veterinară and Institutul de Fizică Atomică, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Biochim., 4: 473-83(1961). (In Romanian)

The albumins and globulins in bovine, equine, porcine, and avian serums were separated by precipitation with half-saturated ammonium sulfate solution. The separated proteins were dissolved in 0.05 M phosphate buffer at pH 6.8 and dialyzed for 24 hr. In this form they were exposed for 1 hr in a nuclear reactor (of the Institute of Atomic Physics, Bucharest) with a flux consisting of thermal neutrons ($2.3 \times 10^7/cm^2/sec$), epithermal neutrons ($7.1 \times 10^5/cm^2/sec$), fast neutrons ($4.0 \times 10^7/cm^2/sec$), and γ radiation (0.06 r/sec). Changes in the polarographic behavior of the proteins, in the presence of Co ion and over the range −1.2 to −1.9 v, and in electrophoretic mobility, on filter paper at pH 8.6 and ionic strength 0.05 Veronal buffer, were examined following irradiation. Irradiation caused a lowering of the amplitude of the polarographic half-wave, at protein concentrations from 0.36 to 2.88 mg/100 ml, and a shift in the peak toward lower voltage values, indicating that irradiation alters the ability of the proteins to bind Co ions. These changes varied with the protein concentration, and for the protein fractions and species examined, avian globulins showed the most marked polarographically demonstrable changes following irradiation. No changes in the electrophoretic mobilities of the various globulins were noted after exposure, and of the albumins, only those of the horse and bird showed increased mobilities postirradiation. It was concluded that irradiation of proteins in a neutron flux produces irreversible changes on the surface groups on the molecules, which are reflected by their ability to bind ions and by their electrostatic charges. (BBB)

38753 OBSERVATIONS ON THE ACCUMULATION OF MONONUCLEAR CELLS AND THE ACTIVITIES OF RETICULUM CELLS IN BONE MARROW OF GUINEA PIGS RECOVERING FROM WHOLE-BODY GAMMA IRRADIATION. P. F. Harris, G. Haigh, and J. H. Kugler (Univ. of Sheffield, Eng.). Acta Haematol., 29: 166-79(1963). (In English)

A study was made of the activities of reticulum cells, especially evidence of their proliferation, at an early stage in the final recovery from irradiation, and of whether the small mononuclear cells which accumulate in the irradiated marrow are a homogeneous group and whether some of them are formed in situ. The guinea pigs studied were irradiated with sublethal (150-200 rad), whole-body doses of Co^{60} γ rays. Quantitative studies of the proliferating bone marrow cells at an early stage of recovery did not show

marked reticulum cell proliferation. However, at this time fat storage and phagocytosis, including lymphocyte ingestion, were commonly seen in reticulum cells, also an accumulation of small mononuclear cells in irradiated marrow. Some of these cells were small lymphocytes and appeared in large numbers in marrow. Others resembled small lymphocytes but the pattern of their nuclear chromatin was different. These cells can synthesize DNA, divide, and are comparable with cells previously termed micromyeloblasts and hematogones. Their small size could result from frequent divisions in larger precursors; but irrespective of the origin of the lymphocyte progenitors, these experiments indicate lymphocyte production in irradiated bone marrow. The observed phagocytosis of erythrocytes by reticulum cells and fat storage, at a time when erythropoietic and granulopoietic recovery are imminent on a large scale, suggests that reticulum cells may have an important metabolic role. By making stored lipid and protein available to regenerating cells at an important stage during recovery from irradiation, reticulum cells may contribute to an environment favoring the growth of hemopoietic cells. This may promote the localization of bone marrow injected into irradiated animals. Although in irradiated marrows there was little evidence that reticulum cells serve as stem cells, in a metabolic capacity their role may be equally vital. (BBB)

38754 SCAR CANCER IN THE ATOMIC BOMB SURVIVORS. Hiroshi Tezuka, Chikao Harano, and Raisuke Shirabe (Nagasaki Univ.). Acta Med. Nagasakiensia, 7: 7-15 (Dec. 1962). (In English)

Development of skin cancer in the burned regions of the extremities of two persons exposed in Nagasaki is described, and these two cases are compared with four similar cases reported in Hiroshima. One of the two Nagasaki cases concerned a 50-yr-old man exposed in the open 1300 m from the hypocenter and incurring extensive flash burns over the upper part of the body. All of the burned areas healed within two months, but four months after exposure a small ulcer developed from a scar on the back of the wrist. Fifteen months after exposure, a squamous cell carcinoma was diagnosed at the edge of the spreading, hemorrhagic ulcer. Metastases were noted at this time in a cubital lymph node, and even though amputation of the arm was carried out, extensive metastasis occurred, followed by death 2 yr after exposure. The 2nd Nagasaki case, a 54-yr-old woman exposed in the open 2400 m from the hypocenter, developed an ulcer on the lower leg which followed a course similar to that of the 1st case. However, diagnosis of squamous cell carcinoma of the skin was not made until 10 yr after exposure. The patient refused amputation and died of metastic cancer 12½ yr postexposure. The findings in the Hiroshima cases were very similar to these, and a survey of development of cancer in wounds and burns among the general population of Japan showed that the age, sex, location of the lesion, and its histologic pattern are similar to those found in the six irradiated cases. However, the latent period was less in the irradiated cases (average 7.2 yr) than in the general population (37 yr). Whether irradiation was involved in the pathogenesis of these cancers could not be determined; no such cancers developing from scars were noted in persons exposed 2400 m beyond the hypocenter. The average latent period for cancer developing from Ra or x-ray treatments in Japan is 15.8 yr, or twice that found in the present cases, but the development of the cancers from ulcers was similar. (BBB)

38755 PERIODONTAL TISSUE CHANGES INDUCED IN YOUNG RATS BY ROENTGEN IRRADIATION OF THE MOLAR REGIONS OR THE HEAD. Asger M. Frandsen (Royal Dental College, Copenhagen). Acta Odontol. Scand., 20: 393-410(Nov. 1962). (In English)

Young rats were x irradiated over the head region with single doses of 1000, 2000, and 3000 r, and other rats received single doses of 1725 and 2400 r administered to the molar regions only. The animals were observed over periods ranging from 2 to 58 days after irradiation. In the first group, the rats irradiated with 1000 r displayed a decreased cellularity of the periodontal membrane, degeneration of osteocytes, and suppressed activity of osteoblasts and osteoclasts. Rats which received 2000 and 3000 r all became moribund or died within 8 to 10 days, exhibiting a characteristic erosion of the epithelial lining of the oral cavity. In the second group, two types of periodontal lesions could be distinguished. One was characterized by severe destruction of the periodontium of either the first or the third molar, leaving the other molars relatively unaffected. These lesions were initiated by ulcerations of adjacent parts of the oral mucous membrane. The other type comprised less severe changes originating in the periodontal tissues proper. They consisted of a lack of proliferation of the interdental papilla epithelium, a deficient inflammatory response, clumping of the collagen, and suppression of the functions of the osteoblasts and osteoclasts. Erosion of the epithelial lining of the oral mucous membrane observed in the 2000 and 3000 r groups is comparable to the loss of epithelial lining of the intestine of animals given total-body irradiation, and succumbing to intestinal radiation death. The loss of oral epithelium may be an important factor in the syndrome leading to oral radiation death, a previously described syndrome. It was significant that when serious periodontal lesions did develop, they were always seen in connection with ulcerations of mucous membrane areas closely related to, but not part of the periodontal tissues. It was also characteristic that the periodontal tissues closest to the mucous membrane lesion were the most affected whereas the remainder were conspicuously unaffected. Severe periodontal lesions were not observed in rats which did not display lesions of the adjacent mucous membrane. Consequently, the severe periodontal destructions observed in some rats did not originate as lesions of the periodontium, but were secondary to ulcerations of the adjacent mucous membrane. The infectious processes thus established expanded relatively unopposed in the radiation-damaged tissue. This mode of development of the severe periodontal lesions is in contrast to observations made on monkeys and dogs, in which the destruction of the periodontium was initiated in the gingiva. In all species, loss or loosening of teeth, caused by inflammatory changes superimposed on decreased resistance to infection, leads to destruction of collagen fibers and resorption of alveolar bone. When rats were subjected to extraction of a molar, this resulted in the development of radio-osteomyelitis in some irradiated animals. This condition was characterized by a penetrating destruction of the jaw of an infectious nature with extensive soft and hard tissue necrosis associated with resorption and sequestration of bone. It was considered to be an extension of an inflammatory necrotizing process initiated by ulcerations of mucous membrane areas adjacent to, but not part of the periodontium. (BBB)

38756 TWO CASES OF CIRRHOTIC LIVER ASSOCIATED WITH THOROTRAST DEPOSITS. Miki Aizawa,

Hiroshi Kobayashi, Koshi Maruyama, and Kazuo Hagihara (Hokkaido Univ., Sapporo). Acta Pathol. Japan., 10: Suppl., 615-20(Nov. 1960.

In the first case, a woman aged 59, admitted to the hospital because of intermittent jaundice and ascites, had an abnormal radiograph of the upper abdomen, showing deposits of opaque material in the liver and spleen and calcified lymph nodes. Diagnostic cerebral angiography had been performed through the left common carotid artery for suspected brain tumor because of epileptic seizures at the age of 41. Autopsy in this case showed cirrhosis with Thorotrast deposits in the densely hyalinized interstitial tissue. Diffuse adenomatous proliferation of cholangiocellular origin was associated with nodular fibrosis near the Thorotrast deposits throughout over the liver, although this was not of a malignant nature. The splenic parenchyma was degenerated, and Thorotrast particles were seen in the follicular areas, but there was no fibrosis. Thorotrast aggregates were detected in the lymph nodes, in bone marrow, and in the scar-like mass surrounding the left common carotid artery where Thorotrast had been injected 19 yr previously. In the second case, a 48-yr-old male developed a slight fever, nausea, and vomiting before being admitted to the hospital. X rays revealed abnormal, dense honeycomb-like reticular patterns in liver and spleen. A biopsied skin lesion, suspected of being a metastatic tumor, was diagnosed as hemangioendothelioma. He died of the primary hepatic tumor. Necropsy findings included hemorrhagic malignant changes of the liver associated with bizarre fibrosis and focal calcification, fibrosis of the spleen, a small nodule in the left shoulder region, and a hard mass in the left cubital region. Although an accurate history of Thorotrast injection could not be elicited, deposition of radioactive particles was detected in the spleen and liver, and in the subcutaneous hard mass in the left cubital region where the injection presumably was made. The histological pattern of the mass in the presumed injection site indicated a nodular proliferation of hyalinized dense connective tissue bearing Thorotrast, accompanied by only slight cellular reaction, and referred to as a Thorotrast granuloma. The spleen was hardened by thick fibrous tissue and focal calcification, and the follicles were almost completely replaced by Thorotrast-laden cells and hyalinized fibrous tissue. Hemangioendothelioma or endothelioma-like granulomatous proliferation in the liver was associated with Thorotrast-laden fibrosis and hemorrhage. It is evident that Thorotrast fibrosis is preceded by phagocytosis by reticuloendothelial cells, and accompanied by minimal inflammatory response and subsequent damage of the cells. It seems probable that the radiation effect of Thorotrast is more responsible for the characteristic Thorotrast fibrosis than the mechanical influence of the particles. In a discussion of this article by other investigators, three new cases of Thorotrast deposits in liver are reported, one of them accompanied by malignancy (a cholangiocarcinoma). (BBB)

38757 RELATION BETWEEN FIELD SIZE AND TOLERANCE OF RABBIT'S BRAIN TO ROENTGEN IRRADIATION (200 kv) VIA A SLIT-SHAPED FIELD. Nils O. Berg and Martin Lindgren (University Hospital, Lund, Sweden). Acta Radiol. (N.S.), 1: 147-68(June 1963). (In English)

The relation between field size and tolerance of rabbit's brain to roentgen irradiation via slit-shaped field, 12 mm to 1 mm wide, was studied. Single skin doses between 2,100 r and 27,000 r were given. After 52 weeks the morphology of the lesions was analyzed. The frequency of injuries as well as the lowest focal dose which produced lesions were determined. The effect of irradiation decreased markedly with reduced width of slit. Resulting curves for the occurrence of necrosis and for discrete lesions are both S-shaped. The shape of the curves is discussed, especially the influence of diffusion processes. Published data on the area factor make it likely that the tolerance curve for the skin will be S-shaped too. (auth)

38758 COBALT, COPPER AND IRON IN ANEMIA ASSOCIATED WITH RADIOTHERAPY OF TUMORS. PRELIMINARY COMMUNICATION. Eino Autio and Jouko Saikkonen (Univ. of Helsinki). Acta Radiol. (N.S.), 1: 169-75(June 1963). (In English)

Patients with carcinoma of the lung and breast and certain other malignant tumors were treated with cobalt, copper, and iron during radiotherapy to prevent anemia. One group of patients was given the full treatment while the other group received only iron. The effect of the three substances given together was superior to that produced by iron alone. (auth)

38759 EFFECTS OF ROENTGENRAYS ON THE ENZYME-SUBSTRATE (LUCIFERASE-LUCIFERIN) SYSTEM OF THE CRUSTACEAN CYPRIDINA. W. Lohmann, C. F. Fowler, and W. H. Perkins (Veterans Administration Hospital, Little Rock, Ark.). Acta Radiol. (N.S.), 1: 183-9 (June 1963). (In English)

Twenty-five lambda of practically pure luciferase solution (0.1 mg/ml of 0.1 M phosphate buffer) or 25 λ of highly purified luciferin solution (0.1 mg/ml of methyl alcohol) were irradiated with different doses of roentgen rays (3,000 to 4.5×10^5 r). The initial flash-height peak, the slope of the reaction curve, and the quantity of light emitted after combination of enzyme and substrate were determined, using photocell equipment. The results of these in vitro experiments show that the substrate is much more radiosensitive than the enzyme. (auth)

38760 LATE EFFECTS OF THOROTRAST IN CEREBRAL ANGIOGRAPHY. R. Blomberg, L.-E. Larsson, B. Lindell, and E. Lindgren (Karolinska Sjukhuset, Stockholm). Acta Radiol., (N.S.), 1: 995-1006(July 1963). (In English)

A follow-up study of part of about 1000 cases which received Thorotrast injections during the years 1932–1947 is reported. Special attention was paid to the appearance of malignancies and the consequences of extravascular deposits of Thorotrast. About half the cases that received extravascular deposits developed severe late complications. Six cases of the total material had hepatic tumors, the incidence apparently being related to the amount of Thorotrast injected. (auth)

38761 ENZYMATIC AND HISTOCHEMICAL STUDIES ON THE ACTION OF IONIZING RADIATIONS IN ANIMAL EXPERIMENTS. I. INVESTIGATION OF SERUM AND TISSUE ENZYMES IN WHOLE-BODY IRRADIATED RATS WITH PARTIAL PROTECTION OF THE INTESTINE. Karl-Heinz Kaercher (Universität, Heidelberg). Aerztl. Forsch., 16: 205-8(Apr. 10, 1962). (In German)

An enzyme of the glycolytic series, lactic dehydrogenase (LDH), and one of the tricarboxylic acid cycle, malic dehydrogenase (MDH), which have been previously shown to undergo changes in tissue destruction and regeneration, were assayed in the serum and tissues of irradiated rats. The rats were exposed to 800-r doses of 200-kv x rays; in some animals a 2 × 2 cm lead shield was placed over the abdomen in the duodenal region during irradiation, and in others an intestinal loop was exteriorized surgically and shielded during exposure. Enzyme assays were made in serum and

homogenates of skin, liver, spleen, and intestine at 1, 3, 5, 10, 12, and 30 days postirradiation. In unshielded rats, serum LDH activity rose 2-fold, from a control level of 13 units to a max of 26 units on the first day, then declined to normal by the 5th day. With intestinal shielding a max on the 3rd day of 22 units was seen. In intestine of unshielded rats, LDH fell markedly, from 283 to 7 units on the 3rd day; then it rose to a max of 940 units on the 12th day. A similar biphasic, but much less pronounced change (min 83, max 450 units) was noted. Serum MDH activity rose markedly in the unprotected rats, from 120 to a max of 680 units on the 5th day; whereas after intestinal shielding the max was lower (184 units) and earlier 3rd day). Without shielding, MDH activity in intestine fell from 8094 to 422 units on the 3rd day, then rose to 45818 units on the 10th day. Shielding raised the min (4321 units, 3rd day) and lowered the max (27501 units, 12th day). These biphasic changes in enzyme activities reflect the destructive and regenerative processes following irradiation, and show that even partial protection of the intestine ameliorates these changes. Moreover, 90% of the shielded animals survived 30 days or longer compared to only 50% of the unprotected rats. (BBB)

38762 CHANGES IN SERUM AND TISSUE ENZYMES UNDER THE INFLUENCE OF IONIZING RADIATIONS. 2. HISTOCHEMICAL ENZYME STUDIES IN SKIN, LIVER, AND INTESTINE OF WHOLE-BODY IRRADIATED RATS. Karl-Heinz Kaercher (Universitlt, Heidelberg). Aerztl. Forsch., 16: 370-7(July 10, 1962). (In German)

Frozen tissue sections were obtained 2 hr to 30 days after whole-body x irradiation of rats with 800 r doses to ascertain changes in lactic dehydrogenase (LDH), diphosphopyridine nucleotide (DPN) diaphorase, and succinic dehydrogenase (SDH) activities. In some rats a 2 × 2 cm lead shield was placed over the abdomen during exposure to shield part of the intestine. LDH and SDH activities, which generally changed in parallel in various tissues, showed a marked drop in unshielded intestine and a complete disappearance by the 3rd day. By the 30th day complete restoration of these activities was present. No changes in their activities were noted in shielded intestine. In the liver, which was not shielded, the depletion of all three enzymes was greater in the absence of intestinal shielding, which suggests that toxic products from irradiated intestine augments liver injury, since in shielded rats the liver enzyme changes were less pronounced. Enzyme changes in skin were similar in the two groups; DPN diaphorase was especially depleted in skin after irradiation but returned to normal within 30 days. The enzyme changes were most marked in the stratum spinosum of the epidermis and hair follicle epithelium. Fibroblasts showed only a transient enzyme depletion, which was followed by a compensatory supranormal rise in activity in some cells in the regenerative phase. The 30-day mortality rates were 50% in the shielded and 10% in the unshielded rats, indicating that substances liberated into the circulation from the radiation-injured intestine may contribute to the lethal action of radiation. (BBB)

38763 RADIATION NEPHRITIS: A CLINICOPATHOLOGIC STUDY. A. I. Rubenstone (Veterans Administration Hospital, Philadelphia) and L. B. Fitch. Am. J. Med., 33: 545-54(Oct. 1962).

Clinical and pathologic findings are correlated in five cases of radiation nephritis in an attempt to establish a new approach to the pathologic criteria for diagnosis, relating not only to clinical course but also to prognosis by use of the percutaneous renal biopsy technic. The investigation showed that in some cases certain elements of the kidney may be affected more severely than others, and that the main clinical findings depend upon which one of these elements is principally affected, i.e., glomerulus, the tubule, or interstitial tissue. The results showed that Luxton's classification of clinical and morphologic criteria of radiation nephritis require modification. Although the majority of clinical cases of radiation nephritis can be classified according to his four types, there remain cases which pass through several clinical phases in their evolution. In one case hypertension developed following radiation, which was relieved by nephrectomy. The hypertension was apparently due to arteritis deformaties of the interlobar arteries with marked narrowing of the lumen. Two other patients showed signs and symptoms of acute radiation nephritis; however, in one the clinical picture of benign hypertension developed later and in the other mild chronic radiation nephritis developed. It is recommended that diagnosis of radiation nephritis be based on five criteria: a history of irradiation, glomerular changes, tubular and parenchymal changes, renal capsular fibrosis, and vascular changes. In glomerular changes, the most important feature was the presence of diffuse involvement of the glomeruli. Marked interstitial fibrosis of the cortex, with atropy and disappearance of the tubules combined with focal regeneration of tubular lining cells, is very suggestive of radiation nephritis. Vascular changes which appeared to be important were the marked involvement of the glomerular capillaries, and of arterioles and small arteries, including interlobular and intralobular arteries. Lipid deposits in glomeruli and small blood vessels, together with fibrinoid necrosis, when present, were suggestive of radiation damage. The results of renal biopsy showed that this method is a useful adjunct in the diagnostic and prognostic assessment of radiation nephritis. (BBB)

38764 THE EFFECTS OF BETA RADIATION ON THE NORMAL CORNEAL ENDOTHELIUM OF THE RABBIT. H. H. Chi, C. C. Teng, and H. M. Katzin (Eye Bank for Sight Restoration, Inc., New York). Am. J. Ophthalmol., 55: 724-33(Apr. 1963).

No pathologic effects were noted in the eyes after local Sr^{90} irradiation of the central areas of the right eye at doses of 6000 and 18,000 rep. Combined alizarin red and hematoxylin stains of the endothelium were used to study changes in the population of multinucleated giant cells, which were observed in the normal corneal endothelium of the control left eye. After doses of 6000 rep, the difference of multinucleated giant cell counts between the two eyes was within the normal limit for the first day, followed by a period of 3 to 7 days during which the formation of these cells in the irradiated eyes was temporarily inhibited. After this period of inhibition, an overcompensating increase of these cells was noted in the third postirradiation week, reaching its peak in the fourth week. By the end of the sixth week this effect had tapered off. After doses of 18,000 rep, the difference of the multinucleated giant cell counts between the two eyes was within the normal limit for the first day. A decrease in the number of these cells was noted in the irradiated eyes 3 days after irradiation. After this period of inhibition, an increase of these cells was noted in the first postirradiation week and the count rose consistently to the 6-week period when the experiments were terminated. Cytologic changes in the corneal endothelium were noted only in the doses of 18,000 rep in the 4- and 6-week period after irradiation but the extent of the cellular damage is not sufficient to cause biomicroscopically visible corneal lesions. No pathologic mitoses

or nuclear fragmentation were observed with the doses and time intervals used. Perhaps insufficiently high doses of radiation were used to demonstrate these changes, especially in mitoses which almost always are limited to the peripheral endothelium. It is concluded that a β-ray dose of 18,000 rep is still not high enough to damage a large number of endothelial cells and, when only a few cells are damaged, these may eventually be replaced or, if the damage to a cell is not severe, recovery is possible. (BBB)

38765 BETA IRRADIATION OF RAT INTESTINE. LONG-TERM STUDIES AFTER DAILY YTTRIUM-90 INGESTION. Maurice F. Sullivan, Sidney Marks, and Roy C. Thompson (General Electric Co., Richland, Wash.). Am. J. Pathol., 43: 527-37(Oct. 1963). (HW-SA-2955)

Mature female rats were maintained for 60 days on drinking water containing yttrium-90. A high-level group of 52 animals ingested an average of 410 μC per day; a low-level group of 51 animals ingested an average of 91 μC per day. Nine animals from the high-level group died during the exposure period, and all animals in this group experienced severe weight loss. The low-level group exhibited no gross symptoms during the exposure period which would distinguish them from the controls. The total radiation dose to the large intestine was estimated to have been about 55,000 rads in the high-level group and about 12,000 rads in the low-level group. Median post-treatment survival times were 350 days for the high-level group, 434 days for the low-level group, and 626 days for control animals. Interesting late effects of particular note in the exposed groups included carcinomas of the oral cavity and uterus in many animals. Contamination of the facial area was considered an important factor in the development of numerous corneal ulcers. Histologic study of the intestinal tract indicated virtually complete recovery of the early damage, and only two intestinal tumors were observed among the exposed animals. (auth)

38766 EFFECT OF FRACTIONATING DOSES ON THE RATE OF X-RAY-INDUCED MUTATIONS IN DROSOPHILA. E. Guyenot, V. Kiortsis, and V. Uehlinger (Univ. of Athens). Ann. Genet., 4: 55-62(1961). (In French)

Radiation produces both point and somatic mutations, the former being in proportion to dosage. The present experiment was conducted on Drosophila melanogaster to determine to what extent fractionation of dose increases or decreases mutation. X irradiation was administered in three ways: continuously, for 10 min; fractionated, with an interval of $^{9}/_{10}$ min between $^{1}/_{10}$-min exposures at an average rate of 70 r/min; fractionated, with an interval of $^{1}/_{15}$ min. In all three cases the total amount of radiation was 700 r. The mutation considered was a sex-linked, lethal recessive in a wild strain of the fruit fly crossed with the Muller 5 strain. According to formulas evolved previously, the average rate of mutation was found to be 12–13% less with short intervals than with continuous irradiation, and 19% less with long intervals than with continuous irradiation. These results were obtained from 21 series of irradiations spread over three stages, each consisting of two groups. Stage A was observed 1–3 days after irradiation; stage B, 4–6 days after; and stage C, 7–9 days after. The conclusion was reached that the mutation rate was progressively reduced when the interval of protection between the fractionated x-ray doses was increased. Furthermore, in the case of point mutations, there is evidence for a recovery phenomenon in the various stages of male gametogenesis. If studied more fully, this aspect of the process could prove important to greater understanding of radioinduced mutation and mutagenesis itself. (BBB)

38767 DEFICITS IN IRRADIATION THERAPY FOR CARCINOMA OF THE LARYNX FOLLOWED BY SURGERY. Herbert H. Harris (Baylor Univ., Houston, Tex.). Ann. Otol. Rhinol. Laryngol., 70: 463-74(June 1961).

A detailed analysis was made in 23 patients, and the results of 286 other cases surveyed, with respect to the optimal field size and the ensuing complications of presurgical irradiation of laryngeal cancer. Two types of radiation therapy were used: 220 kv (conventional apparatus) and 2 Mev (Van de Graaff electrostatic generator). All 23 cases received 36 treatments over a period of ~6 weeks using a port as small as possible, to allow for the fact that surgery might be done later. In none of the cases was a larger port than 8 × 10 cm used. The total x-ray tumor dose varied between 6000 and 7000 r, and when 2 Mev electrons were used the dosage varied between 5000 and 6000 r. The complications as a result of irradiation except in three cases were not great, and it is doubtful if the end results would have been better had surgery been performed initially on those in whom radiation necrosis took place. There was little or no difference in the response of the tissues to surgery to 220-kv x rays and 2-Mev electrons when the tumor dose was the same. (BBB)

38768 THE MODE OF ACTION OF RADIOPROTECTIVE AGENTS. J.-M. Kirrmann (Collège de France, Paris). Annee Biol. (4), 1: 571-84(Nov.-Dec. 1962). (In French)

Since the discovery in 1949 of the first chemical radioprotectors in the animal, there have been proposed different theories to explain the mechanism of the appearance of the radiolesions and the mode of action of radioprotectors. These theories are concisely reported. The mode of action of x rays on cells was explained first by the target theory and then by the addition of the indirect effect theory. The mechanisms of radioprotection by anoxia proposed to explain the manner in which molecular oxygen can modify the types of radicals formed by irradiation are examined. The principal theories on the mechanism of chemical radioprotectors are the reduction theory, the competition theory, and the combination theory. These are briefly reviewed. The evidence of free radicals on the mechanism is indicated. 51 references. (J.S.R.)

38769 RADIOPROTECTION OF OVOMUCOID BY 2-AMINOETHYLISOTHIURONIUM BROMIDE HYDROBROMIDE AGAINST GAMMA RADIATION. M. del C. Fuster, F. Sanz, and M. D. Astudillo (Instituto de Química Física Rocasolano, Madrid). Arch. Inst. Farmacol. Exptl. (Madrid), 14: 65-89(1962). (In Spanish)

The possible radioprotective effect of AET on a mucoprotein was investigated in vitro. Ovomucoid, prepared from egg white by ethanol precipitation, was irradiated with Co^{60} γ rays in the dry form and in 0.1% aqueous solution, with and without added AET, and changes in the uv absorption spectrum were followed. Comparative experiments were conducted on hydrolyzates of ovomucoid, a simulated hydrolyzate composed of a mixture of amino acids and glucosamine, individual amino acids (cystine, methionine, phenylalanine, tyrosine, tryptophan, aspartic acid), and glucosamine. These substances were exposed to γ-ray doses of 765 to 322,406 r. Irradiation of ovomucoid solution in the absence of AET markedly increased the magnitude of the 278-mμ absorption maximum and that of 255-mμ min, without displacing them, in a dose-dependent fashion. After irradiation at the highest dose the upper limit of the maximum extended beyond 390 mμ from a limit of 295 mμ with unirradiated protein solutions. In contrast, irradiation of ovomucoid in the dry form produced only slight changes

in the uv spectrum of the subsequently dissolved mucoprotein. Addition of AET to the solution protected the mucoprotein from radiation as seen by the less marked changes in its uv spectrum. (TCO)

38770 SCREENING METHODS FOR DEMONSTRATION OF THE RADIATION PROTECTION: EFFECTS OF STREPTOMYCES ENZYME JUICES. F. Hernadi, T. Valyi-Nagy, A. Jeney, and G. Valu (Medical Univ., Debrecen, Hungary). Arch. Mikrobiol., 40: 119-25(1961). (In German)

Tests were conducted on Escherichia coli 0 111 and Streptomyces bikiniensis to develop a biological method for screening possible radioprotective agents. The cultures were irradiated with LD_{50} and absolute lethal doses. To examine the sensitivity of the method, three well-known protective agents were tested at doses of 1, 10, 100 μg/0.3 ml suspensions of the microorganisms. These experiments proved that cysteine, cysteamine, and 2-aminoethylisothiuronium at concentrations of 10 to 100 μg/0.3 ml afforded protection to the test microorganisms. Also tested were the SH substances homocysteine thiolactone (HCT), glutathione, methionine, Dicaptol (dimercaptopropanol); amines: serotonin, adrenaline, noradrenaline, histamine; and others: reserpine, chlorpromazine sodium nitrite, malonic dinitrile, and methylene blue. The strongest protection was shown by the three SH substances tested first, but glutathione, HCT and Dicaptol also showed promise. Also tested for protective activity were enzyme extracts of cultures of 40 different strains of Streptomyces. Twenty strains were cultured from radioactive earth and 20 from inactive earth. Of the 40 enzyme extracts tested, only two were protective on E. coli and S. bikiniensis. One protected both microorganisms, the other only E. coli. One of the active strains was cultured from radioactive soil from a uranium mine. This assay method appears to be a useful one for screening possible protective agent for subsequent testing in mammals. (BBB)

38771 KINETICS OF THE ABSORPTION OF A SINGLE DOSE OF GLUCOSE BY THE INTESTINE OF GUINEA PIGS RECEIVING WHOLE-BODY X IRRADIATION. M. Lourau (Institut de Biologie, Paris). Arch. Sci. Physiol., 15: 309-19(May 1961). (In French)

The proposed explanation of the slowing down of glucose absorption in x-irradiated guinea pigs involves two factors active in normal animals: increasing glycemia and progressive dilution of ingested glucose in the stomach. To verify this hypothesis, guinea pigs were irradiated with unfiltered 250-kv x rays at a dose of 500 r. After 14 days they were fed glucose; the amount of glucose absorbed/unit time was found to be a linear function, rather than the logarithmic one for normal animals. Glycemia/unit time was an exponential function for both normal and irradiated animals, with max value occurring at 70 min. In irradiated animals the max was 400 mg% as against 220 mg% for the control group. Concentrations of glucose in the stomach decreased from 140 mg/ml to an average of 56.2 ± 12 mg/ml in control and 60 ± 10 mg/ml in irradiated animals, in the first dilution period. A second stage of dilution occurs at the end of the first hour in normal animals and reduces the original 700 mg of glucose in the stomach at a rate exponential to the amount of glucose remaining. In irradiated animals this phase does not begin until near the experiment's end (the 3rd postabsorption hour). Hence the essential change in absorption after irradiation is that irradiated animals show decreasing volumes and stable concentrations of glucose. It was concluded that the slowing down of absorption at the end of the first postirradiation hour was not due, as once thought, to temporary inhibition of gastric drainage by glucose present in the stomach, but rather due to increased glycemia and decreased concentration. Intestinal absorption was found to be two phased, as are many other radio-induced functions. Delay in glucose metabolism correlates with the disturbance in digestive absorption of glucose in irradiated guinea pigs. (BBB)

38772 SERUM DEXTRAN CLEARANCE: STUDIES IN NORMAL AND ACUTELY IRRADIATED DOGS. Seymour W. Milstein, Yoshio Miyazaki, Leonard Stanton, and John M. Howard (Hahnemann Medical Coll., Philadelphia). Arch. Surg., 84: 454-61(Apr. 1962).

Tests were conducted to evaluate the efficacy of using dextran as a plasma expander during a potential military or civilian mass disaster in which individuals would suffer both blood loss and the effects of whole-body irradiation. To this end the rates of clearance of a standard dextran preparation from the sera of normal control and acutely irradiated dogs were examined. The dogs were x irradiated with 100, 200, and 400 r and given dextran infusions one day after x-ray exposure and bleeding to 25% of their normal blood volume. The pattern of dextran disappearance in control and irradiated dogs was similar. The concentration of dextran in serum, 4 hr after the end of the infusion, as a percentage of the peak level found immediately after infusion, provided the index of the rate of its clearance. This 4-hr dextran level varied from 58% to 68%, using a dextran preparation of molecular wt 170,000. Only a drop of the white blood cell count was noted after irradiation, but no significant change from normal occurred in the handling of the dextran. It was felt that, despite the adequate levels of x-ray exposure employed in these experiments, the postradiation time interval may have been too short to permit full manifestation of the sequelae of radiation injury. Using intervals of 2, 3, 5, and 7 days after exposure to 200 r, only the leukocyte response was found, but no significant difference from normal appeared in the dextran clearance pattern or time. It is concluded that dextran can be used as effectively in acutely irradiated dogs as in normal dogs sustaining a similar blood loss. (BBB)

38773 CHROMOSOME CHANGES AFTER EXPERIMENTAL IRRADIATION IN VIVO. L. Bosi, G. L. Castoldi, N. de Bellis, E. Punturieri, and N. Ricci (Arcispedale S. Anna di Ferrara, Ferrara, Italy). Arcispedale S. Anna Ferrara, 15: 1040-1(1962). (In Italian)

Previous studies of the effect of x rays on chromosomes are discussed and preliminary results are reported of experiments showing chromosome anomalies in rats submitted to 200-r whole-body x irradiation. (BBB)

38774 ULTRASTRUCTURAL FINDINGS IN THE ZONA FASCICULATA OF THE ADRENAL CORTEX IN ANIMALS EXPOSED TO A SINGLE HIGH DOSE OF GENERAL OR LOCAL RADIATION. G. Poggi Longostrevi and L. Lombardi (Università, Milan). Atti Accad. Med. Lombarda, 17: 179-94(Apr.-June 1962). (In Italian)

Electron microscopic observations were made of this adrenocortical zone of male adult rats irradiated with 200-kv x rays. Irradiation was given at a rate of 90 r/min to a total dose of 1000 r, either to the entire body or to a 4 × 6 cm lumbar region over the adrenals. At the earliest time examined, one day postirradiation, the mitochondrial membrane was disrupted and the number of cristae reduced; the nuclear membrane was detached. In contrast to these changes in the zona fasciculata, none were found at this time in the zona glomerulosa. After three days, greater changes were noted in the zona fasciculata: the mitochon-

dria were completely devoid of cristae and were filled with granular material; the endoplasmic reticulum was enormously dilated and vacuolated, some vacuoles appearing as large as mitochondria. Extravasated erythrocytes indicated extensive local, small hemorrhages. After seven days the changes were less marked, some repair of mitochondria was evident and endoplasmic reticulum was less dilated. Ribosomes free in the cytoplasm were noted and defects in the nuclear membrane persisted. The above changes, described as seen in whole-body irradiated rats, were also found after local irradiation, but in the latter case the changes seen at one day resembled those seen at three days in panirradiated rats. The results demonstrated the considerably greater radiosensitivity of the zona fasciculata as compared with the zona glomerulosa, in which little or no change was evident. Since injection of ACTH in rats produces marked changes in mitochondria of the zona fasciculata, resembling those seen here, it is suggested that the stress reaction, induced by irradiation, and the consequent stimulation of hypophyseal ACTH secretion may have been responsible for most of the observed changes, at least in the mitochondrion. The stress reaction appeared to be stimulated by local as well as by whole-body irradiation. (BBB)

38775 ELECTRON MICROSCOPIC STUDY OF CHANGES IN LIVER CELLS AFTER COMBINED TREATMENT WITH CARBON TETRACHLORIDE AND X RAYS. G. Poggi Longostrevi and L. Lombardi (Università, Milan). Atti Accad. Med. Lombarda, 17: 195-204(Apr.-June 1962). (In Italian)

Adult rats were treated with low doses of both CCl_4 and x rays, shown previously not to produce ultrastructural changes in liver parenchymal cells when given separately. The rats were exposed to a single, whole-body, 200-r dose of 160-kv x rays and then injected subcutaneously with 0.1 ml of a 30% solution of CCl_4 in peanut oil, corresponding to 0.15 ml CCl_4 per 100 g body wt. When the rats were sacrificed three days later, all showed pronounced changes in mitochondria and endoplasmic reticulum of liver cells, which were not seen following either individual treatment. The mitochondria showed marked swelling, detachment of cristae, and accumulation of granular material in their interior. Endoplasmic reticulum underwent dilatation and detachment of normally adherent ribonucleoprotein granules. A different picture was observed following injection of toxic doses of CCl_4 (0.5 ml/100 g body wt). This produced marked disruption and ballooning of mitochondria and endoplasmic reticulum. The results indicate that subliminal doses of CCl_4 and x rays, presumably acting by different mechanisms, synergistically damage the liver cell, particularly its mitochondria. (BBB)

38776 VARIATIONS OF HISTAMINE IN TISSUES AFTER IRRADIATION WITH HIGH DOSES OF GAMMA RAYS. L. Mariani, F. Fornasari, and M. Giorgi (Università, Milan). Atti Accad. Med. Lombarda, 17: 221-5(Apr.-June 1962). (In Italian)

Guinea pigs were exposed to 650, 3250, and 6500 r doses of γ rays in a Co^{60} unit of 8000-C strength for period of 7, 35, and 70 sec, respectively. All animals exposed to 650 r died within 15 days, whereas after the two higher doses, death occurred in 2 to 4 days. Histamine content of blood and various organs was assayed 10 min postexposure. Even at the highest radiation doses, none of the animals showed bronchospasm or other evidence of acute histamine release, such as is seen in anaphylactic shock. Blood histamine content was not affected by 650 r but was reduced about 30% 10 min after 3250 r and 60% after 6500 r. In contrast, anaphylactic shock, induced by intravenous injection of ovalbumin in sensitized guinea pigs, caused a 4-fold rise in blood histamine level. After exposure to 3250 r, the histamine content of the following organs decreased: lung (46%), liver (38%), spleen (37%), kidney (17%), intestine (19%), and uterus (7%). The content did not change in heart. In all of these organs the histamine content fell 40 to 70% following anaphylaxis. Thus massive irradiation lowered tissue histamine to a lesser degree than anaphylaxis and caused a drop rather than a rise in its blood level, as compared with anaphylaxis. However, it was shown that in spite of tissue histamine depletion in these lethally irradiated animals, they underwent anaphylactic shock (when previously sensitized and then challenged with ovalbumin) of the same severity as unirradiated sensitized guinea pigs. The mechanism by which massive irradiation lowers the histamine content of tissues is unknown, but the possibility that it may damage the enzyme system (histidine decarboxylase) responsible for the generation of histamine is mentioned. (BBB)

38777 OPERATIVE TECHNICS AND THEIR INDICATIONS IN POSTOPERATIVE AND POSTIRRADIATION URETERAL LESIONS. J. M. Gil-Vernet, Jr. (Facultad de Medicina, Barcelona). Cir. Ginecol. Urol., 16: 273-82 (July-Aug. 1962). (In Spanish)

Urinary tract damage of radiotherapeutic origin is the cause of uremia and death in ~40% of cancer patients who have presumably been cured of their primary disease. Uterine cancer treated by irradiation or hysterectomy, with lymphadenectomy, frequently brings about a sclerotic transformation of subperitoneal tissue giving rise to ureteral compression, complex fistulae, and other urinary symptoms. Ureteral obstruction has also been observed after radium application or x-ray therapy in benign processes, e.g., uterine fibromyomatosis. It has been proven that the ureter is much more vulnerable to irradiation after a total hysterectomy has been performed because disection around the ureter deprives it of its vascular, lymphatic, and nervous connections. Secondary ureteral lesions caused by irradiation should be treated by ureteroileoplasty and only exceptionally by the Boari operation. Ureteroileoplasty is indicated for the following conditions: stenosing periureteritis due to fibrosclerosis of retroperitoneal tissue; and radiotherapeutic sequelae with damage to the ureter extending beyond 9 cm. The small intestine has all the necessary qualifications to make it an ideal substitute for the damaged ureter. Its caliber is appropriate and its contraction wave is similar in amplitude and frequency. A necessary requisite for its adequate function is the correct placement of the graft to insure occurrence of peristalsis in the required direction. A new modification of an older technique has been used, and is described, which corrects its inadequacies. For bilateral ureteral repair, a U-shaped loop of ileum is joined to the upper remnants of the two damaged ureters by its two ends, and to the bladder in its middle section. To correct the right antiperistaltic position of the right-half loop, lateral invaginations are provided at different levels. These provide a valvular action, which on micturition prevents upward reflux. The urine column on colliding with the walls of these valves produces an antiperistaltic wave that moves the refluxed urine back to the bladder. The loop, which should not be excessively long, is fixed to the posterior peritoneum. Ureteroileal anastomoses are situated extraperitoneally. Bilateral ureteroileoplasty, as described here, is a simple operation without complications and gives consistently good results. It also allows the radiotherapist to use max scle-

rosing radiation doses without causing postradiation urinary complications of possible fatal outcome. (BBB)

38778 TREATMENT OF CORNEAL VASCULARIZATION BY STRONTIUM-90 BETA PLAQUE. D. Ainslie, Margaret D. Snelling, and R. E. Ellis (Middlesex Hospital, London). Clin. Radiol., 13: 29(Jan. 1962).

A method is presented whereby unwanted vascularization of the cornea can be prevented following its transplantation, and construction of special Sr^{90} applicators for use with this technique is described. Vascularization occurring within a few days of the operation causes a corneal graft to become opaque, and while at this time the new vessels are very sensitive to radiation, it is essential during the immediate postoperative stage to reduce manipulation of the eye to the min. Strontium-90 β-emitting applicators were therefore designed to provide a method of treatment which could be carried out simply in the ward at the time of the usual eye dressing and to avoid the need to transport the patient to the radiotherapy department. Two basic designs of applicator were used, one to irradiate localized new vessels invading the graft and one to treat the whole cornea and limbus. The first has an active area 7 by 4 mm and a radius of curvature of 1.5 cm. The second is circular with a chord dia of 12 mm and the radius of curvature of the cornea, 1 cm. It is therefore possible either to treat the whole of the cornea or a strip 4-mm in width. The thick silver base of each applicator is mounted on a 9-in. handle so that it may be manipulated safely. During treatments the active surface is held within 1 to 2 mm of conjunctiva or cornea, so that anesthesia of the cornea is not essential. Another type of applicator was designed for use on anesthetized patients where the plaque can be actually laid on the cornea. These applicators have no handles but a 3-mm hook is mounted on the silver rear surface so that they may be manipulated by forceps or a thread. The Sr^{90} foil has a thick silver backing and a thin silver front which avoids danger of contamination. It has a surface dose rate of 150 rad/min and the half-value depth in tissue is 1 mm. Treatment is given when fine, new blood vessels appear, usually between the 10th and 20th postoperative day. A surface dose of 400 to 500 rad is given and may be repeated after a few days. The operator's fingers are protected by lead foil held in position by rubber finger stalls, but no other special precautions are necessary. Early clinical results indicate that new vessels forming in the grafted corneal tissue disappear rapidly following the irradiation. (BBB)

38779 THERAPEUTIC ABORTION ON ACCOUNT OF X-RAY EXAMINATION DURING PREGNANCY. Erling Hammer-Jacobsen (Rigshospitalet, Copenhagen). Danish Med. Bull., 6: 113-22(June 1959). (In English)

In Denmark in recent years, x-ray examination of pregnant women has in some instances been either the sole or a contributory indication for therapeutic abortion. The case histories are discussed of 11 pregnant women who had one or more abdominal x-ray examinations during the first 3 months of pregnancy. Therapeutic abortion was later performed in 8 cases while 3 went on to term. The calculated fetal doses in these cases ranged from 0.3 to 3.7 r. To calculate the dose in the uterus in relation to the rectal dose, measurements were made in a paraffin phantom and Mix D phantom blocks. It was found that the dose at a depth of 10 cm (uterus) is two or three times as large as at a depth of 15 cm (rectum), when using radiation of diagnostic quality. For the purpose of these calculations the fetal dose was assumed to be twice that of the rectum (anteroposterior projection). On the basis of examination of the aborted fetuses and the three children that were born, it was concluded that one of these children, whose development was abnormal, should have been aborted and that four of the induced abortions were unnecessary. The placenta had undergone fibrosis in the case of the abnormal child, who had received 3.7 r 50 days after conception. On the basis of these results and a survey of the literature the following rules are proposed relating to use of radiodiagnosis during the 1st 4 months of pregnancy: Fetal doses of less than ~1 r are presumed to cause no noticeable injury, and consequently provide no indication for therapeutic abortion. Fetal doses between 1 to 10 r are assumed, in some instances, to cause injuries taking the form of diseases, malformations, slow development, or reduced resistance, especially when irradiation occurs between the second and sixth week. Doses should be individually evaluated after measurements with the x-ray units used, and if these doses are reached, therapeutic abortion is advisable. Fetal doses above about 10 r are assumed to involve a great probability of fetal injury, and induction of abortion should therefore be the rule. During the last 5 months of pregnancy the fetus will withstand considerably higher doses, of the order of those occurring in pelvimetry. If abortion is performed, the fetus should always be microscopically examined. When birth follows irradiation of a fetus with doses exceeding about 1 r, the development of the child should be kept under observation. It is recommended that in fertile women, x-ray examination of the abdomen should be performed only during the first 10 days following regular menstruation. This rule should be introduced as a routine by all radiological departments, and radiologists. The physician referring the patient for x-ray examination should state the latest date of menstruation in the reference. If the possibility of pregnancy cannot be excluded, x-ray examination should be avoided or postponed until the last 5 months of pregnancy. Only vitally indicated examinations should be exempted from this rule. Each year in Denmark, it is calculated, about 30,000 abdominal x-ray examinations of women 15-39 yr old are carried out, and about 300 of these women are in their first month of pregnancy. (BBB)

38780 EFFECT OF IONIZING RADIATION ON THE TESTES OF RAT. P. N. Srivastava and R. S. Mathur (Univ. of Rajasthan, Jaipur, India). Experientia, 19: 476-8(1963). (In English)

Wistar rats, 8 weeks old, were subjected to whole-body irradiation in doses of 325 r to a total dose of 1300 r. The changes in irradiated rats were slow and gradual and were hardly perceptible at lower dose levels. At 1300 r, both the external changes and changes in the testes were pronounced. Among marked external changes in the body were the gradual opacity of the lens of the eye, general swelling of the face, sluggishness, and death in a short time. Smears prepared from the testes showed a cessation of mitosis and the clumping of chromatin material. The Golgi bodies, which were circular in outline in the normal spermatocytes, assumed granular appearance in the irradiated specimens and became concentrated as granular mass. The centrosome was also divided into two, moved towards the posterior aspect of the nucleus, and occupied the position near the mitochondrial mass. The mitochondrial rodlets showed peculiar aberration in irradiated rats. They began to aggregate and agglutinate and occupied a juxta nuclear position. (M.C.G.)

38781 REMOTE CARCINOGENIC EFFECTS OF CERTAIN RADIOACTIVE COMPOUNDS. T. A. Kochetkova, G. A. Avrunina, and N. D. Sagaidak (Inst. of Industrial Health and Occupational Diseases, Academy of Medical

Sciences, USSR). Federation Proc., Transl. Suppl., 22: Pt. II, T822-4(Sept.-Oct. 1963).

Insoluble compounds of Fe^{59}-ferric oxide, P^{32}-chromium phosphate, and Au^{198}-colloidal gold administered intratracheally to rats induced squamous cell carcinomas of the lung with metastases to the pleura and regional and mesenteric lymph nodes. Soluble solutions of Na^{24} and Fe^{59} or insoluble Fe^{59}-ferric oxide of low activity did not induce tumors within 24 months. Both the soluble and insoluble radioactive compounds caused degenerative changes and impaired permeability of the walls of the blood vessels followed by the development of perivascular and peribronchial sclerosis. Results indicate that insoluble radioactive compounds may create large depth doses of radiation in the foci of their deposition. (C.H.)

38782 LATE SKELETAL CHANGES OF DOGS AFFECTED BY RADIOACTIVE STRONTIUM. N. N. Litvinov. Federation Proc., Transl. Suppl., 22: Pt. II, T829-32 (Sept.-Oct. 1963).

Skeletal changes are described that were observed in dogs from 9 months to 6 yr after the administration of various doses of Sr^{90}. Ten out of 22 dogs developed malignant bone tumors, 4 developed leukemia, and 3 developed nonskeletal tumors. Data are included from microscopic and radioautographic studies of bones from all dogs. (C.H.)

38783 LARGE PARTICLES OF YTTRIUM-90 RADIOISOTOPES INTRA-ARTERIALLY TO TREAT CANCER. Edgar D. Grady, Walter Sale, and Luther C. Rollins. Fulton County Med. Soc. Bull., 36: 5p.(Feb. 1962).

Large particles (50 to 100 μ) of radioactive beta emitting isotopes (Y^{90}) were proven safe to be given into the arteries of kidney, thigh, and head of rabbits or dogs. Injections in the portal vein of rabbits or in the leg vein of dogs were also found to be safe. Effective and homogeneous trapping can be done in thigh, kidney, liver, and lung. Dosages up to 8 mC per kg of total body weight in dogs are well tolerated. Twelve patients with advanced cancer were treated by injections of such isotopes. There has been good radiation concentration and apparently effective radiotherapy in lung and pelvis. There have been no ill effects or complications in any patients attributable to the treatment with the isotopes. (P.C.H.)

38784 RADIATION OF PARIETAL CELLS WITH AND WITHOUT HISTAMINE STIMULATION. David Beal and Donald J. Ferguson (Univ. of Chicago). Gastroenterology, 44: 797-800(June 1963).

Parietal cells may be useful for the study of certain effects of radiation since their acid secretion and its attendant metabolic apparatus can be turned on and off at will, and the copious flow is easily measured. To find out if these cells are more or less susceptible to radiation damage during increased metabolic activity, gastric mucosa was subjected to intense β radiation either at rest or during continuous histamine stimulation. Radiation in the form of β particles was administered to the gastric pouches (Heidenhain) of dogs by means of a solution of P^{32} in a rubber balloon. The total dose was 4876 to 4977 rad, applied over a period of 4 hr. The average penetration of the β particles from P^{32} in unit density material is 1.58 mm. The balloon wall was about 0.1 mm thick, and the mucosa was ~1 mm thick. Dosage was calculated at 1 mm from the surface of the liquid. After irradiation, serial biopsies were taken from the pouches and the number of parietal cells per gland was estimated. After 1 yr the pouches were resected and a biopsy of the residual stomach was taken for comparison, and at appropriate intervals, 4-hr histamine-stimulated secretory tests were conducted. In the initial postradiation test all animals showed a reduction in secretion down to 40 to 90% of control levels, after which there was further diminution to the lowest average level (3 to 32%) at 20 to 23 days after irradiation. The animals recovered some secretory capacity during the rest of the year, with one dog reaching as high as 65% of the preradiation level. Dogs stimulated during irradiation lost less secretory capacity, and tests often caused the dogs to bleed from their pouches although there was no bleeding before irradiation. During the 15-day period irradiation, there was a reduction of parietal cell numbers in all dogs to 75% of the control. Microscopic changes observed were glandular cell destruction, interstitial edema, and infiltration of plasma cells, and leukocytes. At the time of greatest depression of secretion, the parietal cell count averaged 45% of the control; the count was 23% of the control in the 40- to 60-day period, 24% in the 90- to 110-day period, and 30% at 1 yr. Mucosal thickness at 6 to 8 weeks averaged 0.54 mm compared with 0.90 in normal controls. Microscopic observations at 2 months to 1 yr showed increased fibrosis, vascular intimal thickening, and glandular disarray in the mucosa; glandular cells were smaller and not regularly oriented. The deeper muscular layers did not show any marked histologic change. Thus, depression of parietal cell secretory activity after irradiation was not sudden but gradual, over a period of weeks. Histologic changes suggested that the supporting and vascular structures were more affected than the parietal cells, and that a reduction of blood supply through cellular infiltration and fibrosis may have caused secondary suppression or disappearance of the parietal cells. The comparative absence of immediate lethal effect of radiation on parietal cells is evident, and is consistent with the fact that their activity or inactivity at the time of radiation is of little importance. It is postulated that in the parietal cell, where flow of secretion is high, rapid removal of activated molecules may occur with resulting decrease of damage during functional activity. (BBB)

38785 TREATMENT OF RADIOGENIC RECTITIS BY PREDNISOLONE. Antonio Cavaco Catita (Instituto Português de Oncologia, Lisbon). Gaz. Med. Port., 14: 523-9 (Sept.-Dec. 1961). (In Portuguese)

Observations are reported in 10 patients irradiated for carcinoma of the uterine corpus or cervix. Radiogenic rectitis is a frequent sequel of radiation-treated carcinoma of the uterus, due to the extreme radiosensitivity of the rectal mucosa. It is known that vaginal mucosa is able to sustain 30,000 r without alteration, but rectal mucosa can tolerate only 6000 r. The 10 uterine cervix carcinoma patients were pretreated with a total of 190 mg each of prednisolone over a period of 11 days, and 5 also received 10,400,000 units of penicillin. They were then irradiated, and rectoscopic observations were made on the 1st, 7th, 14th, and 30th day after termination of irradiation. Results showed that cortisone derivatives are the best therapeutic aids for this pathologic condition, both as curative and prophylactic agents. As compared with an equal number of controls, in the treated cases prednisolone reduced the frequency of rectitis by 75% as recorded in the initial observation periods and in the later observation periods to 50%. Due to the increase in rectitis, it was concluded that prednisolone administration should have taken place over a longer period than the 11 days used here. The use of prednisolone as a prophylactic rather than a curative agent is recommended to prevent the occurrence of infectious processes developing due to reduced resistance of the damaged tissues to the bacteria indigenous to the rectum. (TCO)

38786 ON THE PROGNOSTIC SIGNIFICANCE OF THE ERYTHROCYTE SEDIMENTATION RATE, THE LEUKOCYTE COUNT, THE HEMOGLOBIN VALUE, AND BODY WEIGHT IN IRRADIATED AND NONIRRADIATED CANCER PATIENTS. D. Hofmann (Universität, Giessen, Ger.). Geburtsh. Frauenheilk., 22: 539-49(June 1962). (In German)

Changes in these parameters were followed in 672 women with genital carcinoma during and after radiotherapy to determine whether any of them could be used to predict the eventual success of the treatment. All of these parameters were found to be of prognostic value in the 394 patients with carcinoma of the uterine cervix of grades I, II, and III. Erythrocyte sedimentation rate (ESR) was initially elevated in these patients, and in those without recurrence, irradiation caused a prompt and progressive drop in ESR. It continued to rise after radiotherapy in those who later showed tumor recurrence. Similar changes in leukocyte count were seen in this group, the counts falling and staying down after successful treatment or rising when the treatment failed. An inverse relation with respect to the hemoglobin level and body wt was seen, both values progressively increasing in cases later shown to be cured and falling in those which were not. These relations did not hold or were of less prognostic value in patients with carcinomas of the body of the uterus, ovary, or vulva. However, in general, a gradual continual fall in ESR and a rapid fall in leukocyte count were favorable signs following irradiation. (BBB)

38787 GENETICALLY NONTRANSMISSIBLE NUCLEAR DAMAGE INDUCED BY ULTRAVIOLET RADIATION IN THE WASP HABROBRACON. E. A. Loebbecke and R. C. von Borstel (Oak Ridge National Lab., Tenn.). Genetics, 48: 1313-22(Oct. 1963).

A type of nuclear damage that is genetically nontransmissible can be induced prezygotically in the wasp Habrobracon. The damage is expressed as death very early in development. It is not a dominant lethal event because the damage is not expressed in the presence of a second nucleus. It is not a recessive lethal event because the damage cannot be found by genetic testing of the F_1 females. It is not cytoplasmic damage because the total damage when induced by uv radiation responds to photoreactivation, whereas cytoplasmic damage in Habrobracon embryos does not. It is inducible in Habrobracon by uv radiation, apparently also by nitrogen mustard, and to a limited extent by x radiation. The effect is that of a nuclear reactivation which seems to be independent in response from photoreactivation. (auth)

38788 THE EFFECT OF X-IRRADIATION ON SOMATIC CROSSING OVER IN DROSOPHILA MELANOGASTER. Rosanne Abbadessa and Allan B. Burdick (Purdue Univ., Lafayette, Ind.). Genetics, 48: 1345-56(Oct. 1963).

Four different genotypes of Drosophila melanogaster were x irradiated at 1350 r during the first, second, and third larval instars. Treatment with x rays resulted in a threefold increase in the frequency of somatic crossing over, evidenced by incidence of abdominal mosaicism. This effect was influenced by genotype and the ontogenetic time at which irradiation occurred. No mosaic spots were detected in the wings, even after irradiation. It is concluded that if somatic crossing over occurs in the wing anlage, it does so at an extremely low frequency. (auth)

38789 NATURE OF ETHYL METHANESULFONATE INDUCED REVERSIONS OF lac⁻ MUTANTS OF ESCHERICHIA COLI. Norman M. Schwartz (Univ. of Chicago). Genetics, 48: 1357-75(Oct. 1963).

Twenty-three ethylmethanesulfonate-induced and nine uv-light-induced lac⁻ mutants with greatly reduced levels of β-galactosidase activity were isolated in Escherichia coli. EMS mutants were induced to revert to a wild type-like phenotype by aminopurine (AP) but not by uv or EMS. EMS induces transitions, with one class of mutation, probably G:C to A:T being preferentially induced. Ultraviolet-induced mutants are induced to revert to a wild type-like phenotype by uv but not be EMS or AP. Ultraviolet therefore appears to induce mostly nontransition type mutations. Feeder revertants of lac⁻ mutants behave like the wild type in transduction tests, in their β-galactosidase activity and in the electrophoretic behavior of the revertant enzyme: Nonfeeder revertants are all more or less genetically unstable, produce less β-galactosidase and are allele specific in transduction crosses. They therefore appear to be suppressor-type reversions. The β-galactosidases synthesized by "nonfeeder" revertants differ qualitatively from the wild-type enzyme. When a suppressed lac⁻ mutant is crossed with a strain bearing the suppressible lac⁻ allele, the suppressor mutation is found to map close to the pro lac region of the chromosome. One of the suppressors studied was more closely linked to pro and pur than to try, thr, leu, or met. Five different lac⁻ suppressors were jointly transduced with pro, indicating linkage with the pro lac region. (auth)

38790 LINKAGE OF AUTOSOMAL LETHALS FROM A LABORATORY POPULATION OF DROSOPHILA MELANOGASTER. Eliot B. Spiess, Robert B. Helling, and Mary R. Capenos (Univ. of Pittsburgh). Genetics, 48: 1377-88(Oct. 1963).

Lethal second and third chromosomes were extracted by marker techniques from a laboratory population of Drosophila melanogaster (originally Oregon-R Control population of Wallace), which had been maintained at 25°C for over 170 generations. Each lethal chromosome balanced over a dominant marker–crossover suppressor was outcrossed to a multiple recessive stock, and recombinants were tested for lethality in order to determine linkage relations of lethal producing loci. Eighteen second chromosomes displayed a clustering of sites in subterminal left arm (two loci), mid-left arm (three loci), both to left and right of the centromere (seven loci), and very close to the centromere (<0.1 Morgan unit; three loci). Twenty-three third chromosomes were distributed as follows: in subterminal left arm (one locus), mid-left arm (five loci), mid-right arm (one locus), and subterminal right (two loci). At least three second chromosomes were multilocus lethals, with one a double, one a triple, and one a quadruple lethal. The double and triple each carried an allele of the left subterminal site; the quadruple carried an allele of a site in the centromere cluster. Chromosome 3 had only one double multilocus lethal chromosome. The finding of high order multilocus lethals cannot easily be explained as a random phenomenon; it is more likely that specific linkages are being selected for, which either exist in high enough frequency to be observed as multiple lethals in a small sample, or which exist in potentially recombinable form to produce such chromosomes regularly by crossing over. It is evident that some lethals have frequencies higher than expected by random drift, and their importance to total fitness in the population is demonstrated by their persistency in the population over a period of four years. This long survival is true for at least three loci on chromosome 2 and at least two loci on chromosome 3. A general statement concerning the expectation of synthetic lethals from these chromosomes is discussed. (auth)

38791 MORPHOLOGIC AND FUNCTIONAL CHANGES IN THE HAIR FOLLICLE AFTER X IRRADIATION. A. Piredda and A. Toti (Università, Ferrara, Italy). Giorn. Ital. Dermatol., 102: 165-90(May-June 1961). (In Italian)

The effect of x rays on the hair was investigated in 12 human subjects being treated for skin diseases on the scalp with relatively soft radiation (10- to 50-kv). Doses of ~100 r had no apparent effect on hair growth but growth was depressed by subepilating doses of 250-300 r (40-50 kv). This effect was more marked with 50- than with 40-kv x rays, the latter at doses of 250 r producing a 60% decrease in the rate of hair elongation. This depression was first noted 13 days after irradiation and was most marked at the 40th day, whereas by the 60th day the length of irradiated hair had nearly reached that of nonirradiated hair. After epilating doses of 400 to 1000 r, decrease in hair growth was first seen by the 5th to 8th day and loss of hair from the 18th to 20th day. The degree of pigmentation of the scalp did not appear to affect the action of radiation on the hair follicles. Microscopic examination of the hair showed that subepilating doses caused an hourglass-like constriction of the proximal portion of the hair, the extent of constriction being roughly proportional to the dose. In contrast, after epilating doses the hair becomes tapered toward the proximal end. Neither of these effects were seen below 100-r or above 1000-r doses of 50-kv radiation. The hourglass-like constriction was max at a level 3-4 mm above the skin surface, whereas the taper produced by 400–1000 r began at 0 to 1 mm below the surface of the skin. Studies with the polarizing microscope showed that doses above 100 r of 43-kv x rays caused a dose dependent diminution in the birefringence, but in the constricted region the birefringent material appeared to be uniformly and symmetrically distributed with respect to the axis of the hair. After 400–1000 r the birefringence of the tapered end of the hair was also reduced; degree of pigmentation of the scalp did not influence these changes. These morphologic and refractive changes were not seen in the hair follicles of isolated samples of scalp irradiated with doses as high as 20,000 r, showing the importance of metabolic factors on their induction. (BBB)

38792 CHROMOSOME ABERRATIONS IN ONE OF A PAIR OF IDENTICAL TWINS AFTER ROENTGEN IRRADIATION OF THE SPINE. Martin Lindgren and Claes Norryd (Jubileumskliniken, Lund, Sweden). Hereditas, 48: 688-98(1962). (In English)

Among 13 patients exposed to therapeutic x irradiation, only one gave good chromosome preparations from leukocyte cultures. This 5-yr-old boy was one of identical twins. Since his twin brother had never been irradiated, comparative studies were made of the chromosome preparations in an attempt to establish a specific effect of radiation on genetic material. The patient received a total dose of 180-kv x radiation of 4000 rad given over 44 days for treatment of a brain tumor. Leukocytes were cultured 4 days after the last treatment. It was estimated that the spine received 2100 rad. Chromosomes of the irradiated twin differed strikingly from the control in several ways: considerably wider spread of chromosome numbers around the normal human number was evident; karyotypes showed many structurally abnormal chromosomes; and the frequency of polyploid cells was higher. The irradiated brother showed chromosome number variation from 45–52, 16% of the cells deviated from the number 46; 29% contained abnormal chromosomes. Some cells contained one or more dicentrics and other deviations, such as acentrics and new chromosome types. Often different deviations were present in the same cell. The incidence of polyploidy was 0.6% in the healthy twin and 5.3% in the treated one. Structural changes were much more frequent in the polyploid cells than in the diploid cells. In the latter, 29% had structural changes, and 14% of these had dicentrics, while in the polyploids 54% had 1–6 dicentrics. This difference is probably due to the fact that polyploid cells in which each chromosome is repeated at least four times are less radiosensitive than diploid cells. On the polyploid level, therefore, cells even with extensive structural changes are capable of survival and of entering mitosis. The results show that irradiation of the bone marrow may result in multiple changes of the chromosomes. All damaged cells except one contained 46 centromeres, and most of the cells retained normal total chromosome length. This indicates that loss of chromosome material will prevent cells from reentering mitosis. It also shows that the affected cells were in their first mitosis after the irradiation. The fact that the breaks observed were always of the chromosome type suggests that the leukocytes were exposed to irradiation while in resting stage and reacting as single strands. (BBB)

38793 IMMUNOLOGICAL UNRESPONSIVENESS TO PROTEIN ANTIGENS IN RABBITS EXPOSED TO X IRRADIATION OR 6-MERCAPTOPURINE TREATMENT. D. Nachtigal and M. Feldman (Weizmann Inst. of Science, Rehovoth, Israel). Immunology, 6: 356-69(July 1963).

Immune unresponsiveness to human and bovine serum albumin was induced in adult rabbits exposed to 550-r total-body irradiation. Immunogenic doses of antigen, 20–75 mg, were found to be tolerogenic in this system. The degree of unresponsiveness was found to be a function of the time interval between x irradiation and the beginning of antigen administration. The unresponsive animals retained the circulating antigen in quantities detectable by the gel-diffusion technique. These results were similar to the state of unresponsiveness induced by means of 6-mercaptopurine. Thus potentially immunogenic doses of antigen could confer tolerance in x-ray and 6-mercaptopurine treated animals. The level of tolerance depended on the time of first antigen administration in relation to the time of physical or chemical treatment. It is assumed that a minimal ratio between antigen and immune competent cells is an essential factor in inducing immune unresponsiveness, and predicted that, following depletion of such cells in the adult animal, much lower antigen doses would be required for induction. Thus antigen doses which are tolerogenic in newborn rabbits act similarly in adult rabbits which had undergone total-body x irradiation, or treatment with 6-mercaptopurine. However, since these treatments reduce only the numbers of immune competent cells, but have no significant influence on the general body wt or blood volume, the extracellular antigen concentration remains the same in treated and untreated rabbits. Each single competent cell is acted upon by the same concentration of antigen molecules in treated and in nontreated adult animals. This makes the significance of the antigen-competent cell ratio difficult to explain in purely quantitative terms; possibly the physical or chemical treatment not only depletes the number of cells but also induces, following this depletion, the appearance of cells at stages particularly susceptible to induction of unresponsiveness. (BBB)

38794 EFFECT OF X-IRRADIATION ON DNA-LABELLING IN CELLS EXPOSED DURING SYNTHESIS. Alma Howard and Gillian Douglas (Mount Vernon Hospital, Northwood Middx., Eng.). Intern. J. Radiation Biol., 6: 405-15(May 1963). (In English)

Bean roots were exposed to 140 to 2500 r x rays aerobically during a 16- to 17-min immersion in a solution of thymidine labeled with C^{14} or H^3. There was no evidence of increase in the rate of DNA synthesis due to irradiation, nor in the number of cells which became labeled. On the contrary, radiation exposure tended to decrease both these parameters. Appreciable activity remained in the cytoplasm. The amount of cytoplasmic activity not removed by N/1 TCA hydrolysis at 60°C was greater in irradiated than in unirradiated cells. (auth)

38795 VARIATION IN RADIOSENSITIVITY DURING THE CELL-CYCLE OF OEDOGONIUM CARDIACUM. R. J. Horsley and L. A. Fučikovsky (Ontario Cancer Treatment and Research Foundation, Hamilton, Ont.). Intern. J. Radiation Biol., 6: 417-29(May 1963). (In English)

Measurement of cell-viability of Oedogonium cardiacum to Co^{60} radiation at increasing time during several cell cycles shows large cyclic variations as the cells pass synchronously through a radiation-sensitive stage. The beginning of this radiosensitive stage, which is referred to as R_0, can be correlated with the first appearance of a ring which forms at the distal end of the cell. Stage R_0 lasts 4 to 5 hr and ends before prophase. Mitotic stages from prophase to telophase are less sensitive to radiation than the R_0 stage. Preliminary results from dose-survival curves indicate a sixfold increase in radiosensitivity between cells irradiated in the resting stage and those irradiated in the sensitive stage R_0. From kinetic studies of single-cell irradiations, it is shown that the number of times non-survivors divide depends on the stage of the cells at the time of irradiation. Cells in the R_0 stage divide about $1\frac{1}{2}$ times on the average, compared with $2\frac{1}{2}$ times for cells in other stages. Results of irradiation of short chains up to 4-cells long suggests that there is a radiation coupling-effect between cells in a chain. Further, the probability of survival of a short chain is lessened if any cell in the chain is in the R_0 stage at the time of irradiation. (auth)

38796 RADIOSENSITIVITY OF NUCLEAR ATP-SYNTHESIS. H. M. Klouwen and I. Betel (TNO, Rijswijk, Netherlands). Intern. J. Radiation Biol., 6: 441-61(May 1963). (In English)

Rat thymus nuclei were isolated in a sucrose medium. The cytoplasmic contamination of the nuclear preparations, judged by cytological and enzymatic techniques varied from 4 to 7%. The nuclear preparations retain considerable amounts of ATP. As a result of incubation of the nuclei without the addition of any substrates, the ATP content increased. The synthesis of nuclear ATP is a highly radiosensitive process. After irradiation in vivo with x ray doses ranging from 50 to 700 r, the ATP synthesis in isolated nuclei was inhibited. Irradiation of nuclear suspensions in vitro did not inhibit ATP synthesis. ATP metabolism was studied in vivo using P^{32}. The curves showing the specific activities of ATP and P isolated both from nuclei and from total thymus tissue suggest that at least part of the nuclear ATP is supplied by the cytoplasm. The incorporation of P^{32} in nuclear ATP is inhibited by small doses of x irradiation. (auth)

38797 COMPARISON OF CELL-MULTIPLICATION AND COLONY-FORMATION AS CRITERIA FOR RADIATION DAMAGE IN CELLS GROWN IN VITRO. William C. Dewey, Ronald M. Humphrey, and Ann Cork (Univ. of Texas, Houston). Intern. J. Radiation Biol., 6: 463-71(May 1963). (In English)

Mouse L cells growing in vitro in log phase were irradiated with either Co^{60} γ rays or 220-kvp x rays, and the inhibition of both cellular multiplication (growth) and colony formation were studied. Growth inhibition is greatly dependent upon the length of time after irradiation that it is measured; however, the suppression of colony formation is relatively independent of the time of scoring. Growth inhibition measured at 3 to 4 days after irradiation showed less radiation effect than did the suppression of colony formation; whereas, growth inhibition measured at 9 to 10 days after irradiation showed a greater radiation effect, even after correction for the initial mitotic lag. The greater radiation effect exhibited by growth inhibition was present because the colonies that developed from cells surviving irradiation grew at a reduced rate. This decrease in the proliferation rate may be attributed either to an increase in the time required for the irradiated cells to complete their cell cycle or to some of the descendants of the surviving cells failing to divide. (auth)

38798 THE INHIBITION OF INCORPORATION OF RADIOCARBON FROM 2-C^{14}-ACETATE IN PROTEINS BY ROENTGEN IRRADIATION OF ESCHERICHIA COLI B. Klaus Dose and Francesco Bresciani (Max-Planck-Institut für Biophysik, Frankfurt am Main and Università, Naples). Intern. J. Radiation Biol., 6: 473-80(May 1963). (In German)

The incorporation of radiocarbon originating from 2-C^{14}-acetate into the amino acids of the protein fraction of E. coli has the same radiosensitivity as the protein synthesis within the dose range of 10 to 50 krad. The theoretical 37% dose is about 50 krad, if 2-C^{14}-acetate is added to the medium after irradiation. With increasing radiation dose the incorporation of the radiocarbon, however, is much less inhibited than the protein synthesis. In the range above 100 krad the calculated 37% dose for the incorporation of the radiocarbon is about 1.4 Mrad. The biochemistry of the processes involved is discussed. (auth)

38799 PARTIAL MARROW SHIELDING AND TOTAL-BODY IRRADIATION. W. D. Noyes, C. A. Finch, H. Wasserman, and K. Glickman (Univ. of Washington, Seattle). J. Appl. Physiol., 18: 629-32(May 1963).

The effects of shielding one femur on bone marrow morphology and function were studied in rats receiving whole-body irradiation. Animals were exposed to 550 r from a Co^{60} source. Shielding consisted of 100 mm of lead, reducing exposure to one femur to 16 r. Marrow cell counts, radioiron localization in femurs, plasma iron turnover, red cell radioiron utilization, and peripheral cell counts were observed. Phlebotomy in some animals served as a functional stress. There was no observed morphological change in shielded marrow despite marked depopulation of nucleated cells in heavily irradiated marrow. In phlebotomized shielded animals, the rate of hemoglobin synthesis was nearly half that of unirradiated controls although retarded by several days whereas in unshielded animals, hemoglobin synthesis was further delayed and less than a third of control values. Initially the erythropoietic function resides primarily in shielded marrow as evidenced by radioiron localization and marrow cell counts with no evidence of indirect depression. Cellular repopulation appears more rapidly in partially shielded animals and compares favorably with the effectiveness of marrow transfusion. (auth)

38800 TOTAL-BODY RADIATION AND RADIATION TO THE BLOOD FROM RADIOACTIVE PHOSPHORUS. D. L. Weijer, H. E. Duggan, and D. B. Scott (University Hospital, Edmonton, Alberta, Can.). J. Can. Assoc. Radiologists, 13: 117-22(Dec. 1962).

Radiation levels were evaluated in the total body and whole blood in 16 patients treated for polycythemia rubra vera with P^{32}. Total-body doses were calculated on the basis of the following simplifying assumptions: P^{32} not excreted or decayed is uniformly distributed throughout the body, the body is homogeneous and of density unity, the β radiation from the body content of P^{32} is entirely absorbed within the body. The calculation was based on a smooth curve, drawn through points obtained from excreted activity at times of collection, as a measure of activity in the body as a function of time. This provided the integral expression: where M = body mass (kg), I = activity of body content (mc), E = average β-particle energy (0.7 Mev for P^{32}), D_t = body dose to time t(rad)) $D_t = (2.1\ E/M) \int_0^t Idt$ rad. To evaluate the integral, a curve was drawn showing the value of I as a function of time (hr), taking account of decay and both uninary and fecal excretion. The value of the integral is then the area under the curve to time t. The calculated total-body radiation over the first 6 days ranged from 7 to 16 rad. The radiation dose from time of initial dose to complete decay varied from a lower limit between 21 and 25 rad to an upper limit of 50 to 60 rad. These values lie below the level required to produce radiation sickness, and none was observed. In terms of rad/mC P^{32} administered, this gave a variation between 5.3-6.4 and 8.2-9.9 rad/mC from time of initial dose to complete decay. Assuming that about the same amount of P^{32} is present in gonadal tissue as in the average tissue at any time, then the genetic dose will lie in this same range, which is generally considered to be the range of the estimated doubling mutation rate in man (30-80 r). The radiation dose to the blood was found to lie between 1.9 and 8.8 rad/mC, which is a wide range of variation. No correlation was found between total red cell volume and rad/mC administered. Total radiation dose to the blood in the polycythemic patients varied from 12 to 40 rad, which is lower than for whole-body radiation. No immediate suppression of the red cell count was noted. The effect of the P^{32} was not seen until 60 to 100 days after therapy. Since the average life span of a red cell is from about 100 to 120 days, it would appear that P^{32} must halt cell division in the bone marrow, and that the bone marrow is sensitive to relatively low radiation levels. (BBB)

38801 EFFECTS OF FETAL X IRRADIATION ON MAZE-LEARNING ABILITY AND MOTOR COORDINATION IN ALBINO RATS. Joseph C. Sharp (Univ. of Utah, Salt Lake City). J. Comp. Physiol. Psychol., 54: 127-9(1961).

Pregnant rats were exposed to either whole-body or half-body (lower half shielded with lead), 280-r doses of x rays, which were given in 35-r daily doses from the 10th to 17th day of gestation. The offspring of these females were run in a 14-unit water T maze 116 days after birth. Performance measures for the half-body irradiated group did not differ significantly from those for nonirradiated controls. The full-body group differed from the other 2 groups in trials to criterion and rate of learning but not in time spent in the maze. Thus, in water-maze experiments, 73% of control rats and 82% of the half-body rats reached the criterion of one perfect trial by the 21st trial, whereas only 26% of the full-body group did so. The mean numbers of errors plotted against trials showed that the full-body group did not learn as rapidly as did the control and half-body groups and that the controls and half-body groups were similar. In experiments to test the duration of the effects of x irradiation on locomotor coordination, the offspring were tested at each of three different ages for ability to walk along parallel bars. Here, as in the maze experiment, the half-body and control groups performed similarly and were superior to the group receiving full-body irradiation. However, these differences were seen at ages 40 and 90 days, but no longer appeared at 140 days. The similarity of all subgroups at the latest age was due to improvement in the full-body group. It is concluded that there are deleterious effects of x irradiation of fetuses and that these are not secondary effects of the maternal irradiation, since effects from irradiation of the mothers in the half-body group are not transmitted to the fetus in such a way that they cause a detectable deficit in the behaviors measured. (BBB)

38802 PROTECTION OF MICE AGAINST IRRADIATION AND TETANUS BY HOMOLOGOUS BONE MARROW CELLS FROM HYPERIMMUNIZED DONORS. Irwin L. Stoloff and Arthur J. Weiss (Jefferson Medical Coll., Philadelphia). J. Immunol., 91: 1-6(July 1963).

Female mice of inbred strains (101 × C3H, BDF, C57B1, Balb/C, C3H, CBA, and LAF) were immunized with 0.2 ml of alum-precipitated tetanus toxoid subcutaneously, followed in 3 weeks by 0.2 ml of fluid toxoid intravenously. Four days after the last injection the marrow was mechanically dispersed and 10-20 million marrow cells were inoculated intravenously into mice that had received on the previous day a lethal dose of whole-body x irradiation. The LD_{30} for 30 days of each host strain was: BDF, 950 r; LAF, 950 r; 101 × C3H, 900 r; Balb/C, 800 r; C3H, 800 r; C57B1, 800 r; and CBA, 700 r. Mice in which isologous bone marrow cells from hyperimmunized donors were transferred to irradiated hosts showed a high degree of protection against irradiation in all strains studied. The percentage of 30-day irradiation survivors follows: C3H, 100%; 101 × C3H, 100%; CBA, 90%; BDF, 90%; Balb/C, 60%; and C57B1, 70%. There were no survivors among groups irradiated but not protected with bone marrow. The percentage of 7-day survivors after toxin challenge for each of 4 different strains receiving isologous cells from hyperimmunized donors ranged between 67 and 100%. Normal mice, similar in weight to the experimental groups (called toxin controls) all died of tetanus within 48 hr of challenge with toxin. Other results showed that homologous disease does not interfere significantly with the in vivo neutralization of tetanus toxin by antitoxin. It was concluded that homologous disease is a clinical entity which, in some donor-host combinations, is associated with a host-vs-graft reaction and, in one strain combination so far tested, is associated with a graft-vs-host reaction. The experiments showed that the genetic relation between donor and host is a factor in determining which type of immunologic reaction may occur. (TCO)

38803 DECLINE OF ANTIBODY AND IMPAIRED ANAMNESIS FOLLOWING X-RAY. Henry N. Claman (Univ. of Colorado, Denver). J. Immunol., 91: 29-38(July 1963).

Experiments were conducted in rabbits immunized with bovine serum albumin and x irradiated with 400- or 500-r, whole-body doses to show the effect of irradiation given between 2 widely spaced injections of protein antigen on 3 aspects of the antibody response: the rate of continued antibody production reflected by the level of circulating antibody, the subsequent anamnestic response to an injection of antigen, and the avidity of the antibody produced. The effect of x rays on the antibody level differed in the primary and secondary responses. When x ray was delivered during the primary response, a decline in antibody production was evident. That antibody was still being produced in the irradiated animals was evident from a comparison of the antibody half-life (15 to 38 days) with the 5 to 6 day half-life of passively administered antibody. Irradiation was without

effect when given during the declining antibody phase of the secondary response. In either case, the antibody response to a subsequent antigenic injection was greatly inhibited. Irradiation did not alter the change in antibody avidity occurring during the primary and secondary responses. (BBB)

38804 ANTIBODY, LYSOZYME, AND COMPLEMENT LEVELS IN ANIMALS CHEMICALLY PROTECTED AGAINST X IRRADIATION. William A. Hook, Andre J. Toussaint, and Louis H. Muschel (Walter Reed Army Inst. of Research, Washington, D. C.). J. Immunol., 91: 100-6 (July 1963).

Tests were conducted on the effects of protecting animals before irradiation with a mixture of 5 chemical agents, containing -SH groups or promoting anoxia, on certain serum components that may be related to natural immunity, such as normal antibody, lysozyme, and complement. Protection of guinea pigs or rabbits with this mixture against the lethal effects of x rays noticeably lessened the depressive effect of whole-body irradiation on normal serum levels of lysozyme, bacteriophage-neutralizing antibody, and bactericidal antibody. This was apparently caused by the so-called dose-reducing effect of the agents. Neither protection nor irradiation seemed to have a significant effect on hemolytic complement titers of guinea pigs and rabbits. Reduction of a sublethal (500-r) x-ray dose to an estimated effective 250 r by the chemicals did not noticeably protect the immune antibody-forming mechanism of rabbits immunized during the radiosensitive stage of antibody formation. Protection against x irradiation afforded animals by the agents tested was attributed to several mechanisms. Diphenylamine, p-hydroxydiphenyl, and p-aminopropiophenone may protect tissue by lowering its oxygen content, whereas the sulfhydryl compounds cysteine and mercaptoethylamine may have the ability to trap free radicals. (BBB)

38805 GENERAL CONSIDERATION ON THE BIOLOGIC ACTION OF IONIZING RADIATIONS. Manoel Corte-Real (Sociedade Portuguesa de Medicina Interna, Lisbon). J. Med. (Porto), 49: 441-55(Nov. 3, 1962). (In Portuguese)

38806 THE HARMFUL GENETIC EFFECTS OF RADIATION. Harold H. Plough (Amherst Coll., Amherst, Mass.). J. Natl. Med. Assoc., 54: 652-7(Nov. 1962).

Evidence relating to the injurious mutagenic effects of ionizing radiation on biological systems is considered from the point of view of animal experimentation and its pertinence to the increasing radiation burden of human populations. Most evidence for harmful genetic effects from at least the higher doses of radiation comes mainly from studies on Drosophila and the mouse. As in Drosophila, mutations in the mouse appear in linear relation to the dose. One difference in the mouse is that the same radiation dose delivered over a longer period produces fewer mutations than higher intensities. This suggests that some repair may occur during chronic doses at the lower rates. It is pointed out that such data may only be converted into estimates of total radiation damage per roentgen from the total number of genes and the demonstration that the mutations observed, whether lethals or selected visibles, show sensitivities which are average for all genes. The average induced rate for the mouse has been calculated to be 21.3×10^{-6} per gene per r, and for certain specific loci in Drosophila the value is $\sim 1.5 \times 10^{-5}$, suggesting that the mammal is about 16 times more sensitive than the insect. From similar data it was calculated that the dose which would double the natural mutation rate for both flies and mice is about 40 r. This is a convenient figure, and may be used for men on the basis of tabulated spontaneous mutation rates. It is suggested that minor increases in the mutation frequency from low level radiation are imaginary hazards, and that a slight increase in selection would remove many of the harmful mutants as they appear. There is some reason to believe that minor genetic changes are corrected at the cellular level. This position is discussed in terms of recent changes in gene theory relating to microbial genetics. This reveals evidence for a mechanism of repair of radiation damage at the level of the smallest genetic units. It is possible, or even probable, that such a mechanism operates in premeiotic stages between genes in heterozygous condition in higher organisms. Critical tests have not yet been made, but they might show reduced expression of lethals or semilethals in subsequent generations after radiation, as compared with the results at higher doses. They might appear as so-called conversion which might be interpreted as crossing over by partial replication. It is concluded that the genetic hazards of radiation are overemphasized and that minor deleterious mutations are selected out early or are repaired before they appear. (BBB)

38807 SOME EFFECTS OF GAMMA-IRRADIATION ON BARLEY AND ITS MALTING PROPERTIES. K. H. Tipples and F. W. Norris (Univ. of Birmingham, Eng.). J. Sci. Food Agr., 14: 646-54(Sept. 1963).

Irradiation of barley above and below disinfestation levels (16,000 rads) was carried out to study the effects of irradiation and post-irradiation storage on malting properties. Maltose figures and free β-amylase of raw barley increased at low irradiation levels. Respiration rate and rootlet production decreased slightly with increasing irradiation, while malts produced from barley irradiated below 100,000 rads showed little change in α- and β-amylase and in proteinase activities. The effects on micro- and pilot-scale malted barley were sometimes in sharp contrast. Growth of barley seedlings demonstrated that unevenness caused by irradiation was more marked in the plumules than in the roots. Plant height, but not root length, showed the reversal effect. Standard analyses of pilot-scale malts indicated a slight degree of undermodification after irradiation. Technological implications of the irradiation process for disinfestation are discussed. (auth)

38808 MITOTIC ACTIVITY OF IMMUNOLOGICALLY COMPETENT LYMPHOID CELLS TRANSFERRED INTO X-IRRADIATED RECIPIENTS. Avinoam Zlotnick, Jacinto J. Vazquez, and Frank J. Dixon (Scripps Clinic and Research Foundation, La Jolla, Calif.). Lab. Invest., 11: 493-9(June 1962).

A study was made to ascertain whether mitotic activity in cell transfer sites could be readily observed by colchicine-induced mitotic arrest, and, if so, whether the rate of division would be sufficient to indicate that antibody-containing cells could develop from a relatively small number of precursors in a manner similar to that in the intact animal. The results showed that antibody production in the cell transfer system is preceded by significant mitotic activity of the transferred lymphoid cells. Lymph node cells were obtained from rabbits immunized by repeated injections of bovine serum albumin (BSA) or bovine γ-globulin (BGG). Two days before the transfer experiment, recipient rabbits were x irradiated (400 r, total-body) to suppress their immune response, and 100 to 150 million cells were injected subcutaneously into each of three different sites in the abdominal wall; thus, a total of ~400 million cells were transferred to each animal. Immediately after transfer, 1.5 mg I^{131}-BSA or 2.5 mg I^{131}-BGG were injected intravenously into the corresponding recipients. Cells in the connective tissue of the injection sites were examined 1-7 days later, morphologi-

cally, and by immunofluorescence for the presence of antibody. The results showed that there is a line of cytologic development in the cell transfer site leading to the appearance of the typical plasma cell; this cell and its younger precursors contain antibody. Another line of cytologic development was also present, leading to the formation of a cell resembling superficially plasma cells, but differing from them in size, structure of the nucleus, absence of perinuclear halo, and pale cytoplasm. This cell does not contain antibody. The origin of the antibody-containing cell in the transfer system was traced to the transferred sensitized cells. By use of colchicine to arrest mitosis for 2 hr, it was possible to detect a significant mitotic activity in the cell transfer sites. The observed mitotic rates indicate that from 1 day to 4 days after transfer and antigenic stimulation the cells presumably capable of division (large and medium lymphoid cells) did divide once or twice per 24-hr period. Similar mitotic rates were observed in lymphoid tissue in the intact animal during an antibody response. Therefore, the antibody-containing cells observed in transfer sites from the fifth day on may have been derived from any cell type capable of division, including the blast cells. It is concluded that these antibody-containing cells in cell transfer sites could be derived from precursors through successive divisions, and that in the cell transfer system, antibody production is preceded by mitotic activity of the transferred lymphoid cells in a manner similar to that of the lymphoid tissue of the intact animal. (BBB)

38809 THE ROLE OF PREDISPOSING FACTORS IN EXPERIMENTAL FUNGUS INFECTIONS. Walter H. Sheldon and Heinz Bauer (Johns Hopkins Hospital, Baltimore). Lab. Invest., 11: 1184-91(Nov. 1962).

Among other factors, the influence of ionizing radiations on susceptibility to fungus diseases is reviewed. X irradiation singly or in combination with cortisone administration has been employed in the study of experimental fungus diseases, and it has been shown that total-body radiation enhanced infection with Candida albicans, Blastomyces dermatitidis, and Cryptococcus neoformans in mice. Enhanced susceptibility to fungus infections following radiation therapy has also been reported, the mechanism resulting in lowered host resistance being presumably the same as in other infections. (BBB)

38810 HARMFUL EFFECTS OF DIAGNOSTIC IRRADIATION. P. R. J. Burch (General Infirmary, Leeds, Eng.). Lancet, 1: 441-2(Feb. 23, 1963).

Some criticisms are advanced against the basis for the conclusions of Stewart, et al. (Brit. Med. J., 2: 882(1962)) that 8% of their M-series (myeloid and monocytic) leukemias could be traced causally to diagnostic x-ray exposure. It is also possible to explain these results on the basis of predisposition toward leukemia in persons with other diseases wh which required frequent x-ray examinations. The apparent median latent period between the x-ray examination and the onset of an M-series leukemia is 3-4 yr, although in Hiroshima survivors the median latent period for the onset of myeloid leukemia was about 8 yr. Therefore, the apparent median latent period associated with the small doses of diagnostic x rays may be too short. This suggests that in some patients, the initiation phase of leukmogenesis had been completed before the x-ray examination. In contrast, for peripheral therapeutic exposures, there is a suggestion of an apparent median latent period of 7-9 yr, and this is compatible with a causal relation between irradiation and the ensuing myeloid or monocytic leukemia. If there is a causal connection between diagnostic x rays and M-series leukemias, one should expect to find evidence for a consistent dose-response relation. The examinations with the highest exposure rate to the trunk should show the greatest risk. Digestive diseases constitute the largest single category with respect to dose to the trunk, but the exposure rate ratio for this group, M-series/controls, is the lowest (only 1.1) while the highest ratio (2.7) is given for chest x rays. (BBB)

38811 ARTERIAL HYPERTENSION AND IRRADIATION DAMAGE TO THE NERVOUS SYSTEM. A. W. Asscher and S. G. Anson (London Hospital). Lancet, 2: 1343-6(Dec. 29, 1962).

On the basis of previous studies it appeared that irradiation damage to the nervous system might be more severe and more easily produced in hypertensive than in normotensive subjects. This hypothesis was investigated by studying the frequency of neurological complications and vascular lesions in the spinal cord after x irradiation of the cord in hypertensive and normotensive rats. Two weeks before irradiation of the spinal cord, a clip was applied to the right renal artery of the animals to produce hypertension. Single doses of 1500, 2000, or 3000 r were administered to the spinal cord in the cervical and upper thoracic region of hypertensive rats (systolic blood pressure higher than 145 mm Hg) and normotensive rats. After 1500 r to spinal cord, no abnormalities were noted in the normotensive controls during the period of observation. Some hypertensive animals showed transient abnormalities of gait, and during the following week died suddenly. Those remaining died unexpectedly 35-259 days after irradiation without apparent preceding neurological manifestations, although acute vascular lesions were found in the irradiated regions of the spinal cord. The normotensive controls of the 2000-r group showed no abnormalities of gait or of tail sensation, but the hypertensive rats died 67-243 days after irradiation, and ataxic episodes preceding these unexpected deaths in one animal. Histologically, the irradiated segments of the cords showed multiple focal acute vascular necrosis. The smaller arteries in irradiated segments of the cords showed hyaline thickening; some of the smaller vessels were widely dilated and filled with blood, and their walls were necrotic. The white matter of the irradiated parts of these cords showed numerous holes (status spongiosus) in the lateral and dorsal columns. The anterior-horn cells in the irradiated zones were swollen, their nuclei pyknotic and cytoplasm devoid of Nissl granules. No abnormalities, besides thickening of the meninges in the irradiated areas, were found in the cords of the normotensive controls. After 3000 r the normotensive animals of this group showed no abnormalities of gait and survived normally; no vascular lesions were found in their spinal cords. The hypertensive animals died suddenly 43-70 days after irradiation of the cord, and in all, death was preceded by ataxic episodes. Postmortem, numerous foci of acute vascular necrosis were found in the irradiated cord. These experiments suggest that moderate arterial hypertension seriously modifies the effect of x irradiation of the spinal cord. The transience of the ataxia in irradiated hypertensive rats suggests a possible origin in reversible vasoconstriction. When such episodes were followed by sudden death, arterial necrosis was invariably present in the irradiated region of the cord. Moreover, in hypertensive animals in which paraplegia developed, there was widespread necrosis of nerve tissue as well as organized vascular necrosis. A search of hospital records revealed three cases in which high blood pressure was recorded along with necrosis of the brain or spinal cord following therapeutic irradiation. In two of these, large doses of irradiation had been administered, and the necrosis might have been due to irradiation alone. In the

third case, however, necrosis of the spinal cord occurred and one factor which may have determined this individual sensitivity was high blood pressure. (BBB)

38812 EFFECTS OF DIAGNOSTIC IRRADIATION. M. E. Wise (Univ. Leiden). Lancet, 2: 95-6(July 13, 1963).

The criticisms of Burch (cf. abstract 38810) of the causal effect of diagnostic irradiation and leukemia, previously answered by Wise, are reevaluated. Burch still contends that the data on time intervals, for the spondylitics who received radiotherapy and for the Oxford survey population, cannot be reconciled on the hypothesis that the diagnostic x rays to the trunk induced the extra M series (myeloid) leukemias in the Oxford survey. His diagram appears to show that the two distributions of intervals between irradiation and onset are appreciably different. However, his diagram is misleading, and the modes of the two underlying distributions of times to onset following inducing irradiation will probably be found to be nearly the same. The true probability distribution of time intervals is almost certainly much more sharply peaked than is shown in Burch's diagram. He also points out that large doses of irradiation to animals are associated with a relatively short latent period; however, there is no evidence that this holds good in either of the above survey populations. Since it is possible that the two underlying distributions of time intervals are very similar, the radiogenic hypothesis is strengthened even if the intervals for the diagnostic x rays do tend to be shorter. It is difficult to explain such a sharp peak at any time interval on the preleukemic fitness hypothesis. On the other hand the data do indicate a real association between M and L (lymphatic) leukemias and respiratory and genitourinary illnesses in the preceding 5 yr, but this association cannot explain the excess exposures in the various subgroups of M leukemias, particularly those for the 3rd and 4th years before the yr of onset. (BBB)

38813 STRUCTURAL AND FUNCTIONAL (ELECTROENCEPHALOGRAPHIC) CHANGES IN THE POSTNATAL MAMMALIAN BRAIN RESULTING FROM X IRRADIATION OF THE EMBRYO. Roberts Rugh, William F. Caveness, Lyse Duhamel, and Gerhart S. Schwarz (Columbia Univ., New York). Military Med., 128: 392-408(May 1962).

Electroencephalography was used to follow the effect of relatively low levels of exposure to x rays of rat embryos as the effects persisted and changed throughout the critical maturation period of life. It was hoped that such a study might reveal how the electroencephalogram (EEG), at an early stage in life, could indicate the presence of a functional congenital anomaly caused by embryonic x irradiation. Irradiation of the rat embryo at gestational age of 9.5 days with 100 r caused the death of some in utero and of others within the first two weeks after birth, but in the same litters some lived at least for 24 weeks. Rats which survived the first two weeks of postnatal life, but died shortly thereafter showed marked deviations from the normal in their EEG's, independently of the presence of overt congenital anomalies. Rats, similarly exposed in utero but surviving for 24 weeks showed consecutive maturation EEG tracings which were similar to those of controls. Those photic responses which could be elicited were less in x-irradiated than in control rats. Irregularities in the EEG seen in young rats, previously x-irradiated in utero, were usually associated with early or impending death, while identically x-irradiated litter mates, with essentially normal EEG's survived and continued to give almost normal tracings. Electroencephalography may provide, therefore, a supplemental check on the function of a brain previously subjected to x irradiation in utero and be of prognostic significance as to impending death. Congenital anomalies were also observed, especially eye defects and hydrocephalus. A survey of the authors' earlier results in mouse embryos and fetuses shows that the central nervous system in the developing mammalian embryo is particularly radiovulnerable. As neurogenesis begins, the sensitivity of the embryo as a whole rises abruptly, and gross congenital anomalies, usually involving the central nervous system, result from irradiation. Since neuroblasts are present from that time on, through intrauterine life, and for some days after birth, these neural elements make the embryo, fetus, and newborn particularly radiosensitive. It was found that in the embryo or fetus the LD_{50} fluctuates between 95 and 800 r, sometimes showing a 3- or 4-fold change within a 24-hr developmental period. In both mouse and rat it has been established that at the time when neurogenesis is initiated there is the highest probability of producing central nervous system congenital anomalies. (BBB)

38814 CHANGES IN SERUM PROTEINS OF RATS SUBJECTED TO SMALL DOSES OF X RAYS. I. TOTAL PROTEINS. F. A. Paolini and A. Pannella (Università, Pavia, Italy). Minerva Fisioterap., 6: 190-3(Apr.-June 1961). (In Italian)

Serum protein levels were followed by paper electrophoresis in rats exposed to 180-kv x rays either over the whole body or in the liver region. The doses in each instance were 50 to 80 r, and in some rats the same total doses were given as four daily exposures on consecutive days. The serums were examined at 10 and 24 hr and 15 days postirradiation. Focal doses of 50 r did not significantly alter the levels of total proteins or any of the fractions, whereas 80 r to the liver caused a slight increase in γ-globulins which was not reflected by a rise in total serum proteins. This change was noted only on the 15th day and was also seen at this time in rats exposed to whole-body, 50- and 80-r doses. Total proteins rose slightly after 50-r, but not 80-r, panirradiation. Slight decrements in albumin and increments in α_2-globulins were inconsistently present. The most significant change, the late elevation of γ-globulins was attributed to the hyperplasia of lymphoid tissue following its earlier destruction by radiation. The other changes appear to result from a stress reaction and activation of the hypophysealadrenal system, since similar changes can be elicited by injection of ACTH. (BBB)

38815 CHANGES IN SERUM PROTEINS OF RATS SUBJECTED TO SMALL DOSES OF X RAYS. II. GLYCOPROTEINS. F. A. Paolini and A. Pannella (Università, Pavia, Italy). Minerva Fisioterap., 6: 259-62(Sept.-Oct., 1961). (In Italian)

As in earlier studies on total proteins (cf. preceding abstract), rats were exposed to whole-body or abdominal irradiation with low doses, 50 to 80 r given in single or four fractionated doses over 4 days. At 24 hr and 15 days after irradiation serum samples were obtained and treated with 95% ethanol, the glycoproteins remaining in the supernatant after the precipitation of proteins. Glycoproteins were estimated on the basis of their hexose content by the anthrone reaction, glucosamine content by Ehrlich's reagent, and sialic acid content by the Bial reaction. Carbohydrate content of various serum fractions separated by electrophoresis on paper was determined by the periodic acid-Schiff reaction. Irradiation of the liver region with 50 or 80 r did not significantly alter serum glycoprotein levels. Panirradiation with the same doses did elevate total serum glycoproteins as determined chemically on the 15th day and increased the carbohydrate content of albumin, α_1-globulin, and α_2-globulin, while that of γ-globulin decreased. These

changes were interpreted as reflecting a nonspecific stress reaction since they can be simulated by injection of ACTH or adrenal steroids. (BBB)

38816 IMMEDIATE AND LATE CHANGES IN CHROMOSOMES INDUCED IN THE BONE MARROW OF RATS IRRADIATED IN VIVO. E. Punturieri, L. Bosi, G. L. Castoldi, N. Ricci, and N. de Bellis (Universita, Ferrara, Italy). Minerva Fisioterap., 7: 175-8(July-Aug. 1962). (In Italian)

Squash preparations of chromosomes were obtained from the bone marrow cells of 39 female rats of the Morini strain at 6 hr, 4 days, and 30 days after whole-body x irradiation of the animals at a rate of 14 r/min to total doses of 50 to 400 r. Chromatid changes were most marked at 6 hr and, at that time, their frequency was proportional to the dose. These changes were less frequent at 4 days and absent at 30 days postirradiation. For example, at 6 hr the number of chromatid breaks was 124, 43, 19, and 8% greater than the control number at radiation doses of 400, 200, 100, and 50 r, respectively. At 4 days these values were all below 3% and no chromatid injuries were noted at 30 days. The highest incidence of achromatic lesions (10%) and polyploid mitoses (13%) were noted at 6 hr after the 200-r dose. In one rat exposed to 400 r, at 4 days two markedly anomalous chromosomes were seen which were of the type previously noted in urethane-treated mice. The absence of chromosome anomalies 30 days after irradiation indicates the selective elimination of cells with damaged chromosomes; however, the possibilities of the persistence of lines of cells with aberrations too slight to be detected morphologically cannot be overlooked. (BBB)

38817 STUDY OF THE EFFECTS OF RADIATION ON KB TUMOR CELLS CULTURED IN VITRO. E. Benassi, F. Piccotti, G. L. Sannazzari, and E. Comino (Universitâ, Turin). Minerva Fisioterap., 7: 300-5(Nov.-Dec. 1962). (In Italian)

Suspensions of these cell were exposed to 50- to 10,000-r doses of 160-kv x rays. The average percentage of cells surviving was 81% after 50 r, 41% after 100 r, 21% after 200 r, and 12% after 300 r. However, at the higher doses the rate of survival was dependent on the cell count; thus, after 300 r the survival rate increased from 7.5% for 20 cells/ml to 15.8% for 40 cells/ml. After 1000 r the survival rate was <1%, and no cells were recovered from cultures irradiated with 5000 ro 10,000 r. The 1st morphologic change seen in cells irradiated with 50-5000 r was an increased nuclear diameter, which was evident at 48 hr and to some extent proportional to the dose. After 3-4 days giant-cell formation was noted, resulting in cells 2-3 times larger than normal, with multiple nuclei, vacuolated cytoplasm, and granular mitochondria. The metabolic activity of cells irradiated with 500 r, as evaluated by acid production under anaerobic conditions, was not different from that of normal KB cells. (BBB)

38818 INFLUENCE OF IONIZING RADIATIONS ON THE EFFECTS OF HETEROLOGOUS IMMUNE CYTOTOXIN ON KB CELLS CULTURED IN VITRO. E. Benassi, F. Piccotti, E. Comino, and G. L. Sannazzari (Universitâ, Turin). Minerva Fisioterap., 7: 306-12(Nov.-Dec. 1962). (In Italian)

The combined effects of x rays and cytotoxic antibodies on KB cells were studied. Cytotoxic antiserum was prepared by subcutaneous injection of KB cells, emulsified in Freund adjuvant, in rabbits. When the cytotoxic antiserum with a titer of 1:128 was incubated at a dilution of 1:10 for 1 hr at 37° with 10^6 KB cells in 5 ml of culture medium, only about 5% of the cells survived, as determined by their ability to form colonies. Survival was reduced to about 1% when the cells were exposed to a 100-r dose of x rays after incubation with cytotoxic serum and to ~0.5% when they were exposed to the same dose before treatment with immune cytotoxin. After irradiation only, ~40% of the cells survived. Only at doses above 1000 r was the metabolic activity of the cells appreciably depressed, as measured by acid production, but when smaller doses of radiation were combined with cytotoxin treatment, marked inhibition of metabolic activity was noted. This inhibition was greater when x-ray exposure preceded, rather than followed, cytotoxin treatment. Microscopic studies showed that after incubation with cytotoxin the cytoplasm of the cells became vacuolated and granulated, fragments of it broke off into the medium, and the nuclei became shrunken and pyknotic. All of these changes were intensified by concomitant exposure to x rays, particularly when irradiation preceded antiserum treatment. It is concluded that irradiation sensitizes the cells to damage by cytotoxic antibodies. (BBB)

38819 EFFECTS OF WHOLE-BODY Co^{60} IRRADIATION ON THE ELIMINATION OF AN I^{131}-LABELED ANTIGEN. I. STUDY OF THE SENSITIZATION PHENOMENON. F. Piccotti, G. L. Sannazzari, and A. Torretta (Universitâ, Turin). Minerva Fisioterap., 7: 312-20(Nov.-Dec. 1962). (In Italian)

Adult rabbits were sensitized by intradermal injection of 10 μg human serum albumin (HSA), and in some cases exposed 12 hr later to 500-r γ radiation. In other animals irradiation preceded injection of antigen by 12 hr, some received radiation only, and others no treatment. Eight days later I^{131}-labeled HSA was injected intravenously and its rate of elimination from the circulation followed by serial assays of blood radioactivity. In rabbits receiving no treatments, HSA-I^{131} in blood fell to 14% of the initial level and then, at a more rapid rate, to 0.2% by the 7th day. Faster (immune) elimination of antigen was noted in the sensitized rabbits, only 1.2 and 0.14% remaining by the 4th and 5th days. Elimination of antigen was considerably slowed in rabbits receiving irradiation alone, with 18% remaining on the 4th and 0.14% on the 10th day, showing the inhibitory effect of irradiation on the nonimmune mechanisms for removing foreign protein from the circulation. Rabbits irradiated 12 hr after sensitization cleared the antigen from the blood much faster (0.8 and 0.2% remaining at 4 and 5 days) than those irradiated before (12 and 6% at 4 and 5 days) and slightly faster than sensitized but nonirradiated rabbits. The results indicate that antibody is rapidly synthesized after introduction of antigen and that midlethal irradiation 12 hr later does not impair the immune mechanisms for removal of the antigen from the circulation when it is reintroduced 8 days later. In contrast, irradiation before sensitization abolishes the immune mechanism for elimination of antigen. (BBB)

38820 VARIATIONS IN X-RAY RESPONSE DURING THE DIVISION CYCLE OF PARTIALLY SYNCHRONIZED CHINESE HAMSTER CELLS IN CULTURE. W. K. Sinclair and Richard A. Morton (Argonne National Lab., Ill.). Nature, 199: 1158-60(Sept. 21, 1963).

The survival of partially synchronized Chinese hamster cells after a single dose of 750 r of 250 kvp x radiation was examined. The normal surviving fraction of an asynchronous Chinese hamster population at 750 r was about 0.12. Survival ranged from about 0.1 initially to 0.31 at 9-10 hr, only to fall again to about 0.1 at 14 hr as division began. The cells appeared more resistant when synthesizing DNA. Maximum x-ray resistance appeared to coincide almost exactly with the period of maximum labeling. (P.C.H.)

38821 X-RAY INHIBITION OF URETHAN-STIMULATED PROLIFERATION OF LUNG CELLS OF THE MOUSE AS ESTIMATED BY INCORPORATION OF TRITIATED THYMIDINE. William A. Foley, Leonard J. Cole, Beryl J. Ingram, and T. Timothy Crocker (Naval Radiological Defense Lab., San Francisco and Univ. of California, San Francisco). Nature, 199: 1267-8(Sept. 28, 1963).

The uptake of tritiated thymidine by cells of the mouse lung during the first 10 days following a single injection of urethan and/or whole-body x irradiation was investigated. Twenty 5-week-old male mice were given 0.2 ml of a 10% solution of urethan intraperitoneally. Twenty-four hours later, 10 of the urethan-treated mice plus an additional group of 10 normal mice were exposed to 880 rads of whole-body x irradiation. Nonirradiated, untreated mice served as controls. Tritiated thymidine was diluted with physiological saline to give a concentration of 100 μc/ml, and 0.2 ml of this solution was given intraperitoneally to each animal at 6 and 3 hr before killing. In 3 control animals there was an average of about 30 labeled cells per 100 grid areas. Urethan decreased the proportion of nuclei labeled on the first day after injection, but the proportion of labeled nuclei rose in one week to three times the control value. X irradiation alone sharply reduced the proportion of labeled nuclei during days 1 and 2, but the labeling rates returned to control values by day 7. The effect of urethan followed in 24 hr by x irradiation was a marked and persistent reduction in the proportion of cells in DNA synthesis. (M.C.G.)

38822 INDUCTION OF MUTATIONS AND KILLING OF CELLS IN IRRADIATED SPERMATOGONIA OF DROSOPHILA. Per Oftedal (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Nature, 199: 1301-2 (Sept. 28, 1963).

In previous experiments Drosophila melanogaster spermatogonia were irradiated in the 20-hr embryo, the induction of sex-linked recessive lethals was observed, and a nonlinear dose effect curve was found. In an attempt to explain the results quantitatively, a mathematical model for the irradiated population of spermatogonia was formulated and tested at doses of 144 and 267 r. Results seemed to support the hypothesis of differential killing as an explanation for the results after acute irradiation of spermatogonia. It was found that protracted irradiations under some conditions may have a higher observable genetic effect than acute treatments. (M.C.G.)

38823 EFFECT OF TESTOSTERONE AND IRRADIATION ON SARCOMATOUS MICE. R. Ghys (Université Laval, Quebec). Oncologia, 15: 194-212(1962). (In French)

Recent success in separate hormonal and radiologic treatments of cancer patients suggested the application of combined treatment. Observations were made in mice, with grafted cancers, given the combined treatment, and correlated with studies of mice with spontaneous tumors; the latter results will appear in a future publication. Adult C57B1 mice were used as recipients of fragments of J sarcoma, a spontaneous polymorphic tumor from the thigh of homologous mice. The tumors were grafted subcutaneously by means of a trocar to the abdomen of each animal. Testosterone propionate was given in a dose of 25 mg/100 g a week before irradiation. Radiation (50-kv x rays) was applied to the tumor at a rate of 390 r/min, to total doses of 500–5500 r, the animals being protected by a lead shield. Tumor volume was computed by the formula $V = \pi a^2 b/6$ (a = short dia. of tumor; b = long dia.). More useful in judging growth and regression was the mean dia., M.D. = $\sqrt[3]{a^2 b}$. Mice were divided into 8 groups: 1 and 2, control groups, male and female, were grafted with tumor; 3 and 4, males and females, were treated with 5 mg testosterone 3 days after grafting; 5 and 6, males and females, were locally irradiated with 1500 r, 10 days after grafting; 7 and 8, males and females, were treated with both testosterone and irradiation in the doses used above. Groups treated with testosterone injection alone or local irradiation alone all showed a decrease in tumor growth. Effects of irradiation were not sex dependent, but the mean survival time was prolonged by testosterone in females, and slightly shortened in males. After combined treatment the mean survival time was slightly shortened in males and much shortened in females, in comparison with irradiation alone. The conclusion was reached that although testosterone protects the mouse against tumor growth, it protects the tumor even better than the rest of the animal against irradiation. Since some mouse cancers parallel human ones in radiosensitivity, these results may be of clinical importance. (BBB)

38824 MALIGNANT VASCULAR TUMORS IN RABBITS INJECTED INTRAVENOUSLY WITH COLLOIDAL THORIUM DIOXIDE. Richard L. Swarm, Eliza Miller, and Herman J. Michelitch. Pathol. Microbiol., 25: 27-44(1962). (In English)

Thorotrast (3 ml of a 25% colloidal solution of ThO_2) was injected intravenously in 12 New Zealand rabbits, and a second injection of 3 ml was given to 3 of the 12 rabbits 18 days later. One of the three animals given two injections died without tumor 19 months after the injections. Both rabbits given two injections and surviving for 37 months after the injections died with hemangioendotheliomas of the liver and spleen. Death of these two animals followed rupture of the tumors and hematoperitoneum; metastases were present in the lungs. Although four of the nine rabbits given a single injection survived for >37 months, only one, an animal surviving 55 months, developed a vascular tumor. A change in the radiological appearance of the spleen of this animal was detected at 54 months, and autopsy revealed a hemangioendothelioma of spleen. The eight other rabbits given a single injection died before 54 months without gross tumors of the liver or spleen. None of the 12 animals developed carcinoma of the liver, although liver cell carcinomas and adenocarcinomas of bile duct type have been reported in man following the intravenous injection of colloidal ThO_2. In all 12 animals most of the aggregates of ThO_2 were found in spleen, liver, abdominal lymph nodes, and bone marrow. Isolated aggregates were also noted in other lymph nodes and in interstitial tissue of other organs, including ovary. Except for a slight increase in fibrous tissue about the ThO_2 deposits beneath the capsule of the liver, no significant increase in fibrous tissue was demonstrated. Medullary hematopoiesis was normal, and no extramedullary hematopoiesis was demonstrated in the spleen, liver, or hemangioendothelial tumors of any of the rabbits. Scars or Thorotrast deposits were not demonstrated at the injection sites, and none of the rabbits developed tumors at the injection site. (BBB)

38825 THE WAVELENGTH-DEPENDENT FRACTION OF BIOLOGICAL DAMAGE DUE TO THYMINE DIMERS AND TO OTHER TYPES OF LESION IN ULTRAVIOLET-IRRADIATED DNA. Jane K. Setlow (Oak Ridge National Lab., Tenn.). Photochem. Photobiol., 2: 393-9(1963).

The sensitivity of Hemophilus influenzae transforming DNA to monochromatic ultraviolet radiation was determined with and without maximum photoreactivation. The fraction of ultraviolet damage, which is photoreactivable (the photoreactivable sector), is large and varies with the

wavelengths of the inactivating radiation, decreasing at the extremes of the ultraviolet spectrum. Equating photoreactivable damage with thymine dimer damage, the wavelength dependence of photoreactivability and the spectrum for nonphotoreactivable damage were interpreted in terms of the absorption spectra of thymidine and cytosine deoxyriboside. The data suggest that cytosine deoxyriboside alteration is important in nonphotoreactivable biological damage. (auth)

38826 TUMORS FOLLOWING ADMINISTRATION OF THOROTRAST. A REVIEW OF THE LITERATURE. Sven Dahlgren (Karolinska Institutet, Stockholm). Radiographica, No. 4, 87-94(Dec. 1962). (In English)

This review considers various aspects of tumorigenesis by Thorotrast, introduced about 1928 as a new roentgen contrast medium. As a colloidal solution of 25% ThO_2 containing 25% carbohydrate, 50% water, and small amounts of preservatives, 20 ml of Thorotrast is equivalent in radioactivity to about one μg radium. After systematic injection, Thorotrast is deposited in the reticuloendothelial system and only insignificant amounts are excreted. Soon after its introduction, warnings were published against its radioactivity and possible tumor-producing potentialities. As early as 1936 it was shown in lab animals that Thorotrast injected systemically or interperitoneally could induce tumors. In 1947 the first case of Thorotrast tumor in man was described, and now about 70 cases of such malignant tumors have been reported. According to the mode of administration, tumors following injection of Thorotrast may be divided into three groups: (1) tumors due to extravascularly deposited Thorotrast, (2) tumors due to Thorotrast deposited in natural cavities, (3) tumors due to Thorotrast injected intravascularly and deposited in the reticuloendothelial system. Three corresponding tables are provided showing the following data for the reported cases (type and site of tumor, diagnostic use of Thorotrast and its dose, sex and age of the patient, and latent period of tumorigenesis). Since the latent period is very long, it is difficult to observe all patients for a long enough period since many of them die from old age or disease long before the tumors are due to appear; hence it is not surprising that only 68 cases of malignant tumor following Thorotrast have been reported. It is proposed that the following criteria must be satisfied before a tumor appearing in a patient having received Thorotrast can be accepted as induced by this substance: thorotrast particles should be found in the immediate vicinity of the tumor; the latent period should be sufficiently long; and the radiation dose should be sufficiently high. Cases of leukemia attributed to Thorotrast have also been described but are not included in this review In the 1st group described above, Thorotrast particles are found in the tumor which appears as a fibrosing foreign-body granuloma, called thorotrastoma; only three cases of malignant tumors belonging to this group have been described. In Group two, 26 cases of malignant tumors were reported. In Group 3, with 33 malignant tumors ascribed to Thorotrast deposited in the reticuloendothelial system, almost all were localized in the liver or bile ducts. The mean latent period between injection of Thorotrast and appearance of malignant tumors is 17.7 yr. The mean age of the patients at the time of diagnosis of the tumor or death was ~52 yr and the sex (female/male) ratio 15/19. (BBB)

38827 THE ELECTROPHORETIC PATTERN OF SERUM PROTEINS IN NEOPLASTIC DISEASES, WITH PARTICULAR REGARD TO PATIENTS SUBJECTED TO RADIOTHERAPY. L. Magno (Spedali Civili di Brescia, Italy). Radiol. Med. (Turin), 47: 1191-1202(Dec. 1961). (In Italian)

Serum protein fractions were quantitatively determined in 104 patients with lymphoblastomas or carcinomas before and after radiotherapy. Irradiation tended to normalize the serum protein levels, which before irradiation consisted in a reduction in albumin and elevations in α_2- and γ-globulins. (BBB)

38828 PULMONARY FIBROSIS AFTER TELECOBALT THERAPY. Q. Falchi (Università, Genoa). Radiol. Med. (Turin), 48: 245-60(Mar. 1962). (In Italian)

Pathogenetic, histopathologic, clinical, and radiologic findings are reported for a series of 145 patients irradiated in the chest region for malignant diseases. Daily γ-ray doses of 200 r to total doses of 3000 to 8000 r were given over a 4- to 6-week schedule. Several cases of acute bronchopneumonitis were seen but severe lesions were rare, and pulmonary fibrosis did not occur even after doses up to 6000 r of focal irradiation (fields of 6×6 or 8×8 cm). However, with larger fields (12×12 or 15×15 cm) it occurred in mild form after one course of treatments and more severely after several courses (after a total of 10000 to 15000 r). After these high doses, scars in the lung and retraction of the diaphragm could be seen radiologically. It was concluded that the incidence of pulmonary fibrosis and other severe pulmonary lesions is lower following Co^{60} radiotherapy, given in small doses several times weekly, than after conventional x-ray therapy. (BBB)

38829 IRRADIATION OF SCORPIONS OF THE SPECIES CENTRUROIDES LIMPIDUS WITH GAMMA RAYS. Luis Mazzotti, R. H. Rhode, F. Lopez, and J. Telich (Instituto de Salubridad y Enfermedades Tropicales, Mexico City). Rev. Inst. Salubridad Enfermedades Trop. (Mex.), 21: 125-7 (Dec. 1961). (In Spanish)

Although radiation studies have been done on other Arthropoda, mainly with the purpose of their eradication, little is known about the effect of γ rays on scorpions. In this study, four groups of 15 scorpions each were irradiated with γ rays varying in dosage from 4500 to 11,500 r. After a dose of ~4500 r, apparently normal physical activity and food intake were maintained. Longest survival time in this group was 105 days as compared with more than 6 months for the controls. The 8000-r dose produced immediate immobilization with subsequent development of sluggish movement. No food was taken and longest survival time was 33 days. After 10,000 r all movement stopped, all deaths occurring before 17 days. After 11,500 r there was no survival beyond 7 days. The survival time for a control group of 100 scorpions was over 6 months in spite of the high mortality figure for these arachnids in captivity. The results indicate a very high vulnerability in scorpions of this species to γ radiation as compared with arthropods of the class Insecta, which appear to show a much greater resistance. (BBB)

38830 CHANGES IN SERUM PROTEINS OF RATS SUBJECTED TO SMALL DOSES OF X RAYS. III. LIPOPROTEINS (ELECTROPHORETIC STUDY). F. A. Paolini and A. Pannella (Università, Pavia, Italy). Riv. Patol. Clin., 16: 63-70(Feb. 1961). (In Italian)

Paper electrophoresis combined with Sudan black staining was used to follow changes in serum lipoprotein fractions 1 and 15 days after abdominal or whole-body irradiation of rats. Single or four divided doses were given to a total of 50 or 80 r. No significant changes in the fractions were noted after 50- or 80-r abdominal irradiation in single or fractionated doses or after 50- or 80-r single whole-body doses. However, after 80-r, whole-body fractionated

doses a 100% increase in β_3-lipoprotein and slight decreases in α- and β_1-lipoproteins were noted 1 day post-irradiation. Normal levels of these fractions were regained by the 15th day. The β/α lipoprotein ratio was elevated 2-fold in these animals after 1 day but returned to normal by the 15th day. The β_3-lipoprotein fraction found here to be most influenced by irradiation corresponds to the lipoproteins with flotation constant (S_f class) 0-100 as determined by ultracentrifugation. It is postulated that these changes in serum lipoproteins may be related to the rise in plasma heparinoids which has been noted to follow irradiation of various animal species. (BBB)

38831 ACTION OF G 27202 ON LOCAL INFLAMMATORY PROCESSES IN CANCER PATIENTS SUBJECTED TO CONVENTIONAL X-RAY THERAPY: CLINICAL-EXPERIMENTAL INVESTIGATION. Mario Arposio and Lucio Babini (Università, Pavia, Italy). Riv. Patol. Clin., 16: 887-96(Dec. 1961). (In Italian)

G 27202 (1-phenyl-2-(p-hydroxyphenyl)-3,5-dioxy-4-n-butylpyrazolidine), recently shown to be an effective anti-inflammatory agent by Wilhelmi, was tested in 64 cancer patients undergoing radiotherapy for ability to reduce the local reaction to radiation. When G 27202 was applied to the skin as a silicone ointment, it was well tolerated and reduced edema and pain in ~80% of the cases tested and slightly reduced erythema in about half of them. Similar results were obtained when the drug was given orally for two days in doses of 300 or 600 mg/day (in 3 doses of 100 to 200 mg each), and no toxic reactions to it were noted. It was concluded that the drug exhibited an antiphlogistic, antiexudative action in most of the patients tested. (BBB)

38832 EFFECT OF X RADIATION ON CELL PERMEABILITY. Bohumil Hluchovsky and Vladimir Srb (Charles Univ., Hradec Králové, Czechoslovakia). Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove, 4: 477-82(1961). (In Czech.)

A study was made of the effect of a single dose of 1000 r of x rays on the cell permeability in epidermal cells of a variety of Vsetaty onion (Allium cepa), by means of a plasmolytic method. For plasmolysis, M sucrose and 0.64 M KNO_3 solutions of pH 5 were used. In comparison with the controls, for irradiated cells the time of complete plasmolysis was longer if KNO_3 was used as the plasmolytic agent and, on the contrary, shorter when plasmolysis was carried out by sucrose. As an explanation of the different behavior of epidermal cells of A. cepa irradiated with 1000 r towards a nonelectrolyte (sucrose) and an electrolyte (KNO_3) plasmolytic agent, the working hypothesis is proposed that x radiation decreases the polarization of the cell membrane, making it more permeable to water and electrolyte, while the permeability of the membrane to nonelectrolytes is not essentially influenced. Thus, it is suggested, that for plant cells too, the biological effect of relatively low doses of radiation is of greater importance than heretofore thought. (BBB)

38833 A CONTRIBUTION TO THE QUESTION OF INCREASE IN THE SIZE OF THE NUCLEI AFTER IRRADIATION. Vladimir Puza, Antonin Jelinek, Jaromir Lehkoziv, and Karel Lejsek (Charles Univ., Hradec Kralove, Czechoslovakia). Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove, 5: Suppl., 101-5(1962). (In Czech)

The effects of 500- to 1400-r doses of 180-kv x rays on the dimensions of cell nuclei were measured. Monkey heart cells were cultivated in medium 199 of Morgan, Morton, and Parker, which was always changed after irradiation. Three methods of measurement were used, the most accurate of which was planimetry of nuclei drawn from microscopic observations. Within the wide variation in nuclear volume, no significant effect of these doses on nuclear volume could be detected. This result is contrary to previous reports that nuclear size increases following irradiation. (BBB)

38834 CYTOLOGICAL INVESTIGATIONS OF THE EFFECTS OF RADIATION ON NORMAL, REGENERATING, AND BLASTOMATOUS TISSUE. PART II. THE RADIO-INDUCED CHANGE OF FORM OF FUNCTIONS OF NUCLEAR APPARATUS IN CELLS OF IMPLANTED TUMORS. Guenther Carl, Heinz Karl Parchwitz, and Elisabeth Wittekindt (Universität, Bonn). Strahlentherapie, 121: 556-66 (Aug. 1963). (In German)

The effect of ionizing radiation on the resting cell was investigated. The mitotic processes of cell nuclei of Walker-carcinomas and Yoshida-sarcomas were used as a test for the radiation reaction. By counting the states which characterize the mitotic cycle in different intervals after irradiation, it is possible to determine a phase shaped reaction course. During a first state an increased extrusion of the nuclear substance into the cytoplasm appears. In a later state an impoverishment of the cytoplasm of ribonucleoproteins with a simultaneous appearance of much enlarged and stained nucleoli was observed. This was thought to be due to an inhibition of the extrusion events. A dose dependency for the Walker-carcinoma was observed with higher doses, because nuclear damage starts sooner, mostly as pyknoses. There are differences between the radiation reaction of the Walker-carcinoma and the Yoshida-sarcoma. Both have the same appearance but the temporal courses of the different states are not the same. These differences are caused by a different radiation sensitivity of the two inoculation tumors. Results are discussed in connection with reports found in the literature. (auth)

38835 REPORT ON THE HISTOLOGY AND CYTOLOGY OF THE IRRADIATED THYMUS. PART I. Hildegard Braun (Universität, Freiburg i. B.). Strahlentherapie, 121: 567-74(Aug. 1963). (In German)

The composition of the thymus of mice during the first 24 hours after total body irradiation with 800 R was investigated. During the first 2 hours after the radiation insult, a weight decrease of about 13% was found. A further continuous weight decrease appeared after the fourth hour. Quantitative evaluation of the histologic preparation showed that the number of normal lymphocytes decreased rapidly immediately after the insult. Part of these cells emigrate from the organs during the first two hours. This can be responsible for the first weight loss. Furthermore, the cell damage starts without latency after irradiation. Eight hours after irradiation, the highest values for nucleus pycnosis can be found. At this time all lymphocytes are damaged or dead. After the 12th hour normal lymphocytes begin to appear in increasing numbers in the thymus. (auth)

38836 AUTORADIOGRAPHIC INVESTIGATION OF THE INCORPORATION OF S^{35}-SULFATE IN THE DAMAGED CORNEA IN VARIOUS HEALING PHASES AND IN THE ARTIFICIAL VASCULARIZING CORNEA AFTER EFFECTS OF IRRADIATION. Reinhold Schuster (Chirurgische Universitätsklinik, Göttingen, Ger.). Strahlentherapie, 121: 580-98(Aug. 1963). (In German)

Using autoradiography the incorporation of S^{35} in regenerating stroma of the injured cornea of rats was investigated after influence of beta-rays. After irradiation with a Sr^{90}-applicator with a radiation dose of 2400 and 6000 rep a significant decrease up to an almost complete inhibition of

S^{35}-incorporation could be observed in the injured area 10 and 20 days after the perforating injury. During the time of the greatest S^{35}-incorporation (5 days after perforation injury), a significant difference between irradiated and non-irradiated eye could not be observed. After irradiation with a radiation dose of 600 rep a significant difference in comparison with the non-irradiated controls could not be observed during an observation period of 20 days. The observed changes in the incorporation of S^{35} in regenerating stroma tissue following administration of a higher radiation dose must be considered as the expression of a radiation induced disturbance of the mucopolysaccharid synthesis. Twenty two days after injection and beta-irradiation with 2400 rep, vascularisation of the rabbit cornea caused by intralamellar turpentine injection showed a significant inhibition of the vascularisation and a decreased incorporation of S^{35} in comparison to non-irradiated cornea. Using alloxan-induced vascularisations a significant inhibition after irradiation with 2400 rep could not be observed during the observation period mentioned above. (auth)

38837 THE EFFECTS OF IONIZING RADIATION ON THE COENZYME-A-CONTENT IN ANIMAL ORGANS AND INFLUENCES ON IT BY CYSTEAMINE AND RESERPINE. Otfried Strubelt (Universität, Erlangen-Nüremberg). Strahlentherapie, 121: 613-20(Aug. 1963). (In German)

Coenzyme-A-concentration in liver, kidney, intestine, brain, and spleen shows a significant decrease from the 2nd day on after total body irradiation of white mice with 700 R. This enzyme damage cannot be caused by a direct destruction or inactivation of coenzyme-A. Radiation anorexia as well as the pantothenic acid deficiency are not the cause because the coenzyme-A-content of non-irradiated animals which received the same amount of food as the irradiated animals is not changed in spite of great weight losses. Furthermore, the intraperitoneal injection of pantothenol does not inhibit the coenzyme-A decrease in the organs of irradiated animals. Coenzyme-A decrease can be inhibited in liver and brain, but not in the kidneys by administration of cysteamine and reserpine, which increase the survival rate of the irradiated animals. (auth)

38838 THE BEHAVIOR OF C-REACTIVE PROTEINS UNDER IRRADIATION. Wolfgang Keitel and Klaus Neumeister (Medizinische Akademie, Magdeburg, Ger.). Strahlentherapie, 121: 621-4(Aug. 1963). (In German)

The C-reactive protein in serum before the beginning and after ending irradiation in 62 patients who received postoperatively a high dosage of normal x ray to the thoracic and pelvic area because of breast tumor or tumor of the uterus was determined. In 22 thoracic and in seven irradiations an increase of the C-reactive protein was observed after ending the irradiation. The increase is significant statistically ($p = 0.01$). Results are discussed. (auth)

38839 BIOLOGICAL STUDIES ON THE ENERGY TRANSFER OF HIGH-ENERGY ELECTRONS. Karl Peters and Gerhard Breitling (Universität, Tubingen, Ger.). Strahlentherapie, 122: 83-90(Sept. 1963). (In German)

The optimum effect on tissue cultures irradiated with 250 r of 16-Mev-electron radiation was obtained at a depth of 4 cm of Lucite. Co^{60} γ rays showed a greater effect than either monoenergetic electrons of 4 to 16 Mev, or 100- and 220-Kv x rays. From the energy distribution of the electrons, it can be concluded that the biological effectiveness, in the case of the tissue cultures and dosage used, is maximum in the energy range from 200 to 500 Kev, corresponding to an ionization density of about 10 ion pairs/μH_2O. (auth)

38840 DEVELOPMENT TO HATCHING OF CHICK EMBRYOS GIVEN EARLY TREATMENT WITH TRITIATED THYMIDINE. Mary Elmore Sauer, Bruce E. Walker, and Martin Schneider (Univ. of Texas, Galveston). Texas Rept. Biol. Med., 20: 279-83(1962).

Comparative effects of irradiation from tritium and 250-kv x rays were studied in 2- to 3-day-old chick embryos. Through a hole in the shell, 50 μC thymidine-H^3 was applied to the 60- and 69-hr embryos, whereas 200-r x-ray doses were given through the shells of 64-hr embryos. Of 23 control embryos, 12 (52%) hatched, while only 7 of 25 (28%) thymidine-H^3 treated embryos hatched. Of these seven, three appeared to be normal, while the remaining four had defects involving one or both hind limbs. Limb injuries included slight weakness of a foot (69-hr), paralysis of both hind limbs (69-hr), and spastic paralysis of both feet (two, 60-hr). Three of the controls were also defective. Autopsy on a gross basis revealed normal morphology in all chicks of both the control and treated groups; average wt of normal controls was 39 g, as opposed to 35 g for treated chicks. Brain samples taken one day following hatching from treated chicks contained over 10 times the background radiation as measured in untreated controls. Only one of the 11 x-irradiated embryos hatched, although the majority lived to hatching age and were grossly normal. Thus, with hatching as the criterion, thymidine-H^3 is considerably less injurious than the x irradiation. However, some effects occurred in the thymidine-H^3 treated chicks for a smaller proportion of these than the controls hatched. Development was a little slower, slightly prolonging both the period of incubation and the period of hatching; and gross defects in behavior appeared in a higher proportion of the treated than of the control group, although again not significantly. In both the thymidine-treated and control groups the defects were of neural or muscular origin, affecting the hind limbs, but were more severe in the treated chicks. It is concluded that 50 μC of thymidine-H^3 applied to 2- to 3-day chick embryos is less injurious than 200-r x irradiation. (BBB)

38841 EFFECTS OF RADIATION ON THE NERVOUS SYSTEM. Bo Sorbo. Tidskr. Mil. Halsovard, 87: 33-41 (1962).

Data presented and discussed at the IAEA Symposium held at Vienna in 1961 are reviewed. (BBB)

38842 LATE RECTITIS INDUCED BY RADIOTHERAPY. F. Barbier (Rijksuniversiteit Polikliniek, Ghent). Tijdschr. Gastroenterol., 5: 453-9(1962). (In Dutch)

Clinical and histopathologic findings are reported relating to 49 cases of late radiation rectitis following Ra and x-ray therapy of cancer of the uterine cervix. Proctoscopy revealed nonulcerative rectitis in 22 cases, a single rectal ulcer in 22 cases, and extensive periproctitis in 4 cases. Rectal bleeding was the most prominent symptom. The occurrence of late manifestation and very slow healing of the lesions are cited as characteristic of this condition. Prophylaxis and treatment are discussed. (BBB)

38843 THE PROCESS OF THE ORIGIN OF FORMS OF OATS UNDER THE INFLUENCE OF IONIZING RADIATION. I. E. Glushchenko and G. M. Zakharova. Tr. Inst. Genet., Akad. Nauk SSSR, No. 29, 164-77(1962).

Dry seeds of the varieties Pobeda and Dippe, both of which have white grains and are either awnless or slender-awned, were exposed to x-ray doses of 13000 and 8000 r, respectively. In both cases, the X_1 and X_2 generations displayed wide variability in respect to awn characteristics, five categories being recognized: awnless; awns; coarse

awns; coarse, slightly curved awns; and coarse curved awns. The progeny of nonirradiated control material contained only the first two categories. The X_3 and X_4 generations derived from plants having the last type awn contained a significant proportion of fatuoids, the actual number varying in different families. The X_3 of Pobeda contained 4.3% of fatuoids and the X_4 5.5%, the corresponding figures for Dippe being 9.4 and 32.7%. One X_3 Pobeda plant and two X_3 Dippe plants bore a mixture of normal and fatuoid spikelets. No fatuoids occurred in control material or in the X_3 and X_4 derived from awnless or straight-awned plants. The occurrence of fatuoids is attributed to physiological disturbances, which results in an unstable hereditary base in forms with crude, curved awns. (TCO)

38844 THE EFFECT OF SINGLE AND REPEATED X-RAY DOSES ON THE GROWTH AND DEVELOPMENT OF MAIZE. O. V. Tovmasyan. Tr. Inst. Genet., Akad. Nauk SSSR, No. 29, 178-84(1962).

Dry seeds of a midlate variety, Sterling zubovidnyj, and two early varieties, Belyaroye psheno and Rumynskaya zheltaya, were exposed to x-ray doses ranging from 1000 to 24000 r one month prior to sowing. The effects on different dosages on the growth and development of plants from the treated seeds and from untreated control seeds were recorded noting varietal differences in response. In Sterling and Rumynskaya zheltaya, the 1000–2000 r doses stimulated growth and reduced the length of the vegetative period. In Belyaroye psheno, the same doses increased percent germination and survival. Higher doses generally delayed growth, caused developmental anomalies and reduced grain set. It was noted that only Sterling survived the highest dose, while Rumynskaya zheltaya failed to survive doses of 14000 r or more. Tests in 1958 on Sterling showed that the stimulating effect of a 2000 r dose was inherited by plants of the following generation. However, this dosage rate depressed growth when seeds of Sterling were exposed to it in two successive seasons and the adverse effects of the 4000 r rate were substantially increased when irradiation was similarly repeated. The 4000 r dose was shown to decrease in size and to increase the sterility of pollen grains of Sterling. (OTS)

38845 THE INFLUENCE OF SEED STORAGE ON THE TERMINAL EFFECT OF GAMMA IRRADIATION (Co^{60}). M. M. Tushnyakova. Tr. Inst. Genet., Akad. Nauk SSSR, No. 29, 185-93(1962).

Seeds of two varieties of oats, Avena sativa and A. nuda, were treated with x-ray doses ranging from 15000 to 30000 r. In the case of A. nuda, seed of the previous harvest and seed stored for 5 years were used but only fresh seed of A. sativa was treated. One portion of the 5-year old A. nuda was irradiated on April 7, 1958, and sown 4 weeks later together with control non-irradiated seed. The 15 kr dose slightly reduced germination and survival and induced morphological and physiological variability. Although the seeds set, their yield was markedly lower than in the controls. The effects were augmented when higher doses were applied. Germination was reduced by approximately 10% for each 5 kr increment in dose. In contrast, the reduction in survival with increasing dose displayed geometric progression, falling from 80% at 15 kr to 27.55 at 20 kr and 0.5% at 25 kr. The control material showed 90.5% germination and 99.4% survival. A similar pattern was observed when fresh A. nuda seed of the previous harvest was irradiated and then stored for two years. Subsequent sowing tests showed that the germination and survival capacity of the material gradually decreased during storage, particularly when higher dosage rates were used. Similar results were obtained with A. sativa seed. Thus when seed was exposed to 25 kr and stored for 14 months, survival capacity was nil, except when gibberellic acid or various other chemicals were used to treat seed after irradiation, in which case 1–3% survival was noted. (OTS)

38846 RESULTS OF THE IRRADIATION OF HEN'S EGGS WITH SMALL DOSES OF GAMMA RAYS. A. Ya. Dobrynina, I. G. Kostin, and L. A. Zubareva. Tr. Inst. Genet., Akad. Nauk SSSR, No. 29, 332-44(1962).

The function of the reproductive system of hens and cocks irradiated during incubation and the embryonic viability of their progeny were studied. U and Th salts were used as sources of radiation and eggs from Russian White and New Hampshire hens were exposed at the rate of 0.0001–0.0002 r/min once for 5–10 min, or up to 7 regular intervals, or continuously (chronically) during incubation. Because of a high negative correlation between control and irradiated eggs, $r \approx -0.585$, it is considered that the incubation quality of eggs must be taken into account when determining the effect of irradiation. There was a positive relation between hatchability and dose when the eggs were exposed at regular intervals, an increase in dose from 1 to 20 mr increased the difference in hatchability in favor of the trial eggs from 2 to about 3½% with 91–92% hatchability in controls and from 4 to 7% with 88–89%. With chronic irradiation, however, the effect diminished with increase in dose, from a difference of about 4% above controls with 1 to about 2% with 3½ r. There were no significant differences in survival or weight gain of chickens irradiated at intervals in embryo compared with controls. During the 9th and 10th months hens irradiated chronically or at intervals in embryo laid 9–16% more eggs than controls. There was no significant difference caused by irradiation in quality of sperm from cocks. Hatchability and other incubation qualities of eggs from hens irradiated in embryo were no worse than in controls. (OTS)

38847 ON THE TRANSMITTED EFFECT OF X-RAY IRRADIATION ON THE TOBACCO MOSAIC VIRUS IN PLANT TISSUES. T. S. Pol''yapol'skaya. Tr. Inst. Genet., Akad. Nauk SSSR, No. 29, 420-4(1962).

Experiments were designed to show whether a temporary reduction in TMV accumulation radioinduced in tobacco leaves could be spread from an irradiated part of the leaf to adjacent protected parts. Isolated leaves of Nicotiana tabacum were used, five leaves being taken for each experiment. A strip 2–2.4 cm wide in the central part of one half of the leaf was irradiated, while adjacent portions were shielded by two lead plates. The other half of the leaf was completely protected by one of the lead plates during irradiation and served as a control. The dose applied was 15 kr, the duration of exposure being 25 min. At fixed times after irradiation, test and control material was infected with TMW, which was then permitted to accumulate under suitable conditions. The degree of accumulation was assessed by applying viral inocula from the exposed and protected strips of the experimental leaf halves and the corresponding strips of the control halves on different halves of 10 N. glutinosa leaves. Data are presented showing the average number of necroses induced per half-leaf of N. glutinosa, with intervals ranging from 2 to 48 hours. The results clearly demonstrated that there was a marked reduction in TMV accumulation in the treated half-leaves in the protected portion as well as in the irradiated strips, and that this reduction was not influenced by intervals of 2 to 24 hours. It was shown that the depressive effect on TMV accumulation in

the tissues adjacent to the irradiated strip was a transmitted effect and was not caused by reflected diffuse radiation. (TCO)

38848 ON THE RELATION BETWEEN THE DOSE OF IONIZING RADIATION AND ITS TERATOGENIC EFFECT. Paul de Bellefeuille (Univ. of Ottawa). Union Med. Canada, 91: 407-11(Apr. 1962). (In French)

Various previously reported data were reevaluated by regression and correlation analysis to show the existence of a linear relation between the radiation dose and the induction of malformations. In experimental animals, this linear pattern obtains both for teratogenesis induced through gonad irradiation (prior to conception) and for that due to exposure of the fetus, although the latter appears to be very much more sensitive to a given dose of radiation than the germ cells. In man, analysis of atomic-bomb survivor data confirms the linear dose-effect relation in the production of microcephalus following fetal irradiation, as well as in the increased risk of leukemia after postnatal exposure. The range over which the significant correlations are observed extends down to doses of the order of 15 to 25 r. On this basis it is predicted that a small, but definite risk of ill effects from diagnostic radiological procedures exists if the pregnant uterus, or the preclimacteric gonad, is subjected to direct irradiation. Available data, however, do not permit determination of whether the genetic effect of radiation in man also shows a linear dose-effect relation, although it is possible to demonstrate the statistical significance of the total genetic effect observed in the first generation offspring of the Japanese survivors. The increased incidence of malformations, which forms part of this effect, is not significant when considered alone. It is estimated that the teratogenic effect in these survivors can be expressed as a 10% increase in malformations per roentgen of gonadal dose. (BBB)

38849 ON THE TREATMENT OF CHANGES IN THE VAGINA FOLLOWING RADIOTHERAPY FOR GYNECOLOGIC CANCER. E. Picha (Universitäts-Frauenklinik, Vienna). Wien. Med. Wochschr., 112: 110-12(Feb. 3, 1962). (In German)

The clinical management of 152 women showing vaginal changes as a result of radiotherapy is reported. These changes occurred in addition to the general radiation syndrome, leucopenia, and injury to the bladder and rectum in some cases. Of prime importance are changes in the bacterial flora of the vagina following irradiation and leukorrhea was a common symptom, which in some cases appeared months after radiotherapy. Leukorrhea developed in response partly to increased bacterial proliferation in vagina and partly to radionecrosis of normal and tumor tissue. However, necrosis and ulceration of vaginal mucosa was usually self-correcting, and healing followed without further treatment. On the other hand, necrosis immediately around the tumor, which may have resulted from excessive radiation dosage, does require treatment. The vaginal changes frequently resemble senile colpitis, and may respond to estrogen therapy for a 6-10 day period. Leukorrhea and necrosis responded best to local applications of salve or ointment containing 50% sulfonamides, 5% lactic acid, and 12.5% salicylic acid. Sulfonamides reduce infection, lactic acid lowers vaginal pH and promotes development of the normal flora (especially Doederlein's bacillus), and salicylic acid inhibits scar formation. Successful results with this treatment, applied for weeks or months, are described. (BBB)

38850 GASTROINTESTINAL DISTURBANCES AFTER RADIOTHERAPY AND THEIR TREATMENT. K. Weghaupt (Universitäts-Frauenklinik, Vienna). Wien. Med. Wochschr., 112: 641-3(Aug. 25, 1962). (In German)

The nature of radiation injury to the intestinal mucosa is discussed, and from a survey of 250 irradiated patients the occurrence of this injury and its treatment are reported. All of these patients were women, most of them being treated with Ra or x rays for uterine cervical carcinoma. The most frequent postirradiation complaints and complications were loss of appetite, anemia, wt loss, pain, and secondary infection. Loss of digestive ability was almost invariably present and was treated by giving vitamins and enzyme preparations. Imbalances in the normal intestinal flora occurred with overgrowth of paracoli and Proteus and disappearance of the normal colon bacillus population. This led to the production of toxic bacterial substances, which, when absorbed from the intestine, deleteriously affected the patient. To correct this imbalance, Lactobacillus acidophilus was given orally in yoghurt up to 6 times daily. This resulted within several weeks in the reestablishment of a normal flora, and 198 of the 250 patients so treated showed general improvement. (BBB)

38851 TRITIUM SUBSTITUTION FOR ESR INVESTIGATIONS. Werner Damerau, Cuenter Lassmann, and Hans-Guenter Thom (Inst. for Medicine and Biology, Berlin). Z. Physik. Chem. (Leipzig), 223: 99-101(1963). (In German)

Because of the low energy of the β radiation of T, a series of perturbation effects could be avoided by application of tritium as an internal radiation source. This is true especially for the study of paramagnetic centers, as they arise as a rule by radiation effects. The application possibilities of tritium are discussed on the basis of examples. (tr-auth)

38852 LE CESIUM 137 EN TELETHERAPIE. (Cesium-137 in Teletherapy). R. Almaric and J. P. Vigne. Paris, Gauthier-Villars & Cie, [nd.] 198p.

A general review centered on the practical utilization of Cs^{137} teletherapy was drawn from various bibliographic data and from the personal experiences of the author. The topics discussed are the physical basis, practical radiodosimetry, apparatus proposed, principal irradiation techniques, the first clinical results, advantages and disadvantages of Cs therapy, and the therapeutic indications of the method. 132 references. (J.S.R.)

38853 RADIODERMATITIS. E. Epstein. Springfield, Ill., Charles C. Thomas, 1962. 178p. $7.75.

This multi-authored monograph deals with the history, cause, clinical symptoms, histopathology, diagnosis, prognosis, and treatment of radiodermatitis. (BBB)

38854 THE RELATION OF REPAIR TO DIFFERENTIAL RADIOSENSITIVITY IN THE PRODUCTION OF MUTATIONS IN PARAMECIUM. R. F. Kimball (Oak Ridge National Lab., Tenn.). p.167-78 of "Repair from Genetic Radiation." New York, Pergamon Press, 1963.

A reasonably complete explanation of the changes in sensitivity to mutation induction during a single cell generation is offered for Paramecium on the basis of two classes of reparable premutational damage with different properties. One class can give rise to two-hit mutational events and is presumed to be chromosomal breakage. The breaks are assumed to have the properties usually attributed to them; they can rejoin either in new arrangements to form two-break aberrations or restitute by rejoining in

the initial arrangement, and they rejoin before DNA synthesis. The second class of premutational damage gives rise to about two-thirds of the mutational events when paramecia are irradiated just before chromosome replication and is presumed to be non-breakage events. This class is subject to repair up to the time of chromosome replication when any remaining damage is converted, with some probability, to final mutation. It gives rise only to one-hit mutations. Discussion is also given on repair. (P.C.H.)

38855 IN VIVO ALTERATIONS IN CHROMOSOME MORPHOLOGY INDUCED IN THE RAT BY IONIZING RADIATION. G. L. Castoldi, N. De Bellis, E. Punturieri, N. Ricci, and L. Bosi (Università, Ferrara, Italy). p.469-71 of "Atti VI° Congresso Nazionale di Radiobiologia Medica, Trieste, Apr. 26-8, 1962." (In Italian)

Experiments are reported in which rats were irradiated with 250-kv x-rays to total doses of 50, 100, 200, and 400 r. Chromosomes of bone marrow cells were examined 6 and 96 hr and 30 days later. The most consistent changes seen were chromatid breaks, which were prevalent at the 6-hr period and in proportion to the dose, and much less frequent at 96 hr. These changes were not seen at 30 days. (BBB)

38856 PERVICHNYE MEKHANIZMY BIOLOGICHESKOGO DEISTVIYA IONIZIRUYUSHCHIKH IZLUCHENII. TRUDY MOSKOVSKOGO OBSHCHESTVA ISPYTALELEI PRIRODY. TOM VII. (The Primary Mechanisms [of] Biological Action of Ionizing Radiations. Transactions of the Moscow Society of Naturalists. Vol. VII). V. I. Korogodin. Moscow, Publishing House of the Academy of Sciences, 1963. 224p.

Twenty-five papers are included on experimental studies of direct and indirect biological effects of ionizing radiation. Kinetics of primary oxidation reactions in radiation injuries and biological effects during latent periods are discussed. Problems of genetic order and the nature of primary processes inducing somatic and genetic injuries, and the role played by secondary radiation injuries affecting mutation processes are analyzed. Separate abstracts have been prepared for each paper. (R.V.J.)

38857 ON DIRECT AND INDIRECT ACTION OF RADIATION UPON BIOLOGICAL SYSTEMS. J. L. Schechtman. p.9-14 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

Various theories of direct and indirect radiation action upon biological systems are discussed. It was shown that effects on cells are essentially due to direct action of ionizing radiation. Mechanisms of direct action of radiation upon cells are considered as well as the role of structured water in the radiation effect. It will be noted that from the viewpoint of the direct action theory, the oxygen effect in radiobiology may involve several different mechanisms. (auth)

38858 THE RELATIVE ROLE OF "INDIRECT" AND "DIRECT" OXYGEN EFFECT IN THE PRIMARY MECHANISM OF BIOLOGICAL ACTION OF IONIZING RADIATIONS. S. N. Ardashnikov. p.15-29 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

The principal facts and statements about the direct and indirect oxygen effects are analyzed. The radiolysis of water, the conception of the modified hit theory, and the so-called methionic reaction are considered. It is shown that by standard methods, in particular by using radiations with different LET, the dilemma could not be solved. (A.G.W.)

38859 DAMAGE OF METAL CONTAINING ENZYMES AS A PRIMARY MANIFESTATION OF THE BIOLOGICAL ACTION OF PENETRATION RADIATION. S. E. Manoilov. p.30-41 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

A decisive role for the mechanism of the biological action of penetrating radiation is played by a direct destruction of metal-containing enzyme systems participating in tissue respiration. To this group we relate various enzymes in which iron is contained in a reduced form, such as DPNH, metal flavoproteins, cytochromes, myoglobin, hemoglobin, etc. Penetrating radiation, irrespective of its type, calls forth oxidation of the bivalent metals along with a disruption of the bond between these elements and the protein carrier. This results in a derangement of the processes of tissue respiration and, consequently, in a decrease of synthetic processes as well as of all other functions of the animal organism, and finally in its death. (auth)

38860 A STUDY OF DNA RADIOSENSITIVITY OF THE MOLECULAR LEVEL. P. I. Tseitlin, T. S. Usakovskaya, D. M. Spitkovskii, and V S. Tongur. p.42-6 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

It was shown that a variety of non-specific agents calls forth a similar quantitative change of the liminal DNA viscosity value as due to a change in the configuration of the DNA macromolecules. The non-protein models of DNP (DNA compressed by the effect of pH, sound and complex formation with methyamine) and their reaction to ionizing radiation point to the suggestion that the higher radiosensitivity of DNA as compared with DNP is due to certain configurational peculiarities of DNA of the nucleoprotein complex as compared with non-protein DNA samples. (auth)

38861 ON THE CORRELATION BETWEEN THE DATA OF RADIATION CHEMISTRY OF POLYNUCLEOTIDES AND OF THEIR PRECURSORS AND SOME RADIOBIOLOGICAL EFFECT. M. I. Shalnov. p.47-59 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

Radiochemical yields of decomposition of polynucleotides and of their precursors are considered as a function of the initial concentration in aqueous solutions within a wide concentration zone. A greater radiosensitivity of pyrimidines as compared with purines is indicated. The correlation between this sensitivity and the relative decrease of pyrimidine incorporation, as compared with purines, into the newly synthesized nucleic acids of daughter cells following irradiation is considered. The fact that daughter RNA and DNA contain less uracil and thymine is attributed to the radiochemical decomposition of low molecular precursors in the irradiated maternal cells. The possibility is discussed of incorporation into the daughter DNA of peroxide derivatives of pyrimidine nucleotides presumably formed upon irradiation. A comparison was made between the rates of the radiochemical and radiobiological reactions. (auth)

38862 KINETICS OF THE PRIMARY OXIDATIVE REACTIONS OF THE RADIATION INJURY. B. N. Tarusov. p.60-72 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

To ascertain the mechanisms of the primary reactions

an analysis was carried out of the kinetic peculiarities of the oxygen effect, particularly of the newly established fact that protection may be effected not only by a decrease but also by an increase of oxygen pressure. The analysis showed that the kinetic pattern is similar to the anomalous dependence of the reaction rate on oxygen pressure, which is characteristic of all oxidative reactions developing according to the chain mechanisms. It was shown that the primary chain reactions of oxidation of structural biolipids are not the only type primary radiochemical reactions in the biosubstrates. The inadequacy of defense-antioxidative agents is accounted for by the existence of primary reactions of nonoxidative character. (auth)

38863 FREE RADICAL STATES AND PROCESSES IN EXPERIMENTAL RADIOBIOLOGY AND SOME NEW POSSIBILITIES OF DEVELOPING MEANS AGAINST RADIATION INJURY. N. M. Emanuel. p.73-83 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

The mechanism of action of ionizing radiation upon biological systems is discussed on the basis of the most general concepts of chemical kinetics, radiation chemistry, and biochemistry. Use of non-toxic inhibitors of radical reactions is suggested to compensate for biochemical changes of a free-radical pattern within the injured organism. The possibility is discussed of developing prophylactic and therapeutic agents against radiation disease with functional groups appropriate to the inhibitors of the radical-chain processes. (auth)

38864 ON PRIMARY TOXIC COMPOUNDS IN THE RADIATION INJURY OF ANIMALS (TOXIC PROPERTIES OF OXIDIZED OLEIC ACID). Yu. B. Kudryashov and V. Malts. p.84-92 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

In the tissues of living irradiated animals there occur some disturbances that lead to the formation of cytotoxins; these are assayed in in vitro experiments. Neither presence nor absence of cytotoxins in in vivo irradiated animals has been proved so far. Experiments on models are reported, which are expected to contribute in future to the study of the mechanism of cytotoxin formation in the organism of irradiated animals. (auth)

38865 A LIPID MODEL OF RADIATION DISEASE AND ANTIRADIATION PROPHYLAXIS. A. I. Zhuravlev. p.93-101 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

It is shown that all the familiar means of chemical protection against radiation injury are lipid antioxidants. The antioxidant properties define also the prophylactic effect of antibiotics and natural SH-compounds. The mechanism of action of antioxidants is due to their capacity to inactivate free radicals and thereby to inhibit the development of the chain reactions of oxidation. (auth)

38866 NEW DATA ON THE MECHANISM OF ACTION OF PROTECTORS. E. F. Romantsev. p.102-7 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

It was shown that the oxygen effect can be used to account for certain aspects of the mechanism of action of protectors belonging to various classes of chemical compounds, such as aminothiols, biogenic amines, amino acids, cyanophores, etc. It was demonstrated that after administration of protectors oxygen concentration in some tissues is altered, the formation of peroxide-like compounds decreases, and the release of Dishe compounds with urine becomes normal. A brief analysis is presented of some hypotheses of the mechanism of protective action. (auth)

38867 ON THE DEVELOPMENT IN THE RADIATION DISEASE OF A DESTRUCTIVE AUTOLYSIS-LIKE PROCESS. V. N. Benevolenskii. p.108-12 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

Most obscure in the mechanism of action of ionizing radiations is the transition from the primary radiation and physicochemical reactions to the secondary biochemical and physiological disturbances. A study of the hemolytic factor of the tissues of irradiated animals showed that this transition is apparently accomplished through the appearance of an autolysis-like process based on activation of autolytic enzymes. Activation of these enzymes is first of all a result of decomposition of labile physicochemical structures of tissues, lipoproteins in particular. The initial breakdown of protein complexes with other compounds is due to the development in them of primary physicochemical reactions, mostly oxidative but of some other nature as well. (auth)

38868 THE INFLUENCE OF THE AUTOLYTIC PROCESSES UPON THE ELECTRICAL PARAMETERS OF TISSUES OF IRRADIATED ANIMALS. E. V. Burlakova and I. M. Parkhomenko. p.113-17 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

The variation of the low-frequency and the high-frequency resistance in surviving liver tissues of white mice exposed to gamma rays of cobalt in vivo was examined. It was established that the irradiation of the animal with doses 800–1000 r results in the increase of dispersion of resistance and the value of the low-frequency and high-frequency resistance. The investigation of the variation of resistance and the autolytic processes of the surviving liver tissue in exposed mice revealed an increase of the autolytic processes, which develops in parallel with the rise of the low-frequency resistance value. A direct correlative connection between these processes was established. The value of their correlative ratio during the first hour is equal to 0.88, for the second hour it amounts to 0.86, and for the third hour it is 0.81. The treatment of the liver with unithiole leads to the reduction of both the rate of the autolytic processes and the value of resistance in the surviving liver tissue. This reduction is greater in the liver of the exposed mice than in that of the control. The $NaNO_2$ solutions (0.5–2% concentrations) radically decrease the autolysis both in the control and in the liver of exposed mice. The amount of aminonitrogen in the liver homogenate of the control and exposed animals becomes identical, i.e., the action of $NaNO_2$ removes the difference in the course of the autolytic processes revealed in the exposed and control animals. (auth)

38869 ON THE RADIATION AFTER-EFFECT IN ERYTHROCYTES. Yu. A. Kriger. p.118-21 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

Erythrocytes irradiated with prehemolytic doses of γ rays (8–10 kr) are more susceptible to photodynamic action than control ones not undergoing hemolysis. The percentage of the so-called reversion of hemolysis is

greatly reduced by irradiation of erythrocytes with the above γ-ray doses as compared with the non-irradiated control. It is suggested that the radicals formed in the dispersion medium play a role in damaging the lipoprotein complexes—the basis of the physicochemical organization of erythrocytes. (auth)

38870 ON LOCALIZATION OF THE PRIMARY REACTIONS OF RADIATION INJURY IN SUBMICROSTRUCTURES OF TISSUES. A. I. Polivoda and E. N. Sekamova. p.122-6 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

It is generally recognized that one of the major microstructural units of tissues and cells is the lipoprotein complex represented by 150–170 Å monolayers. One of the loci of initiation of primary reactions of radiation injury is the lipoprotein complex of the cells and tissues, so that the question arises as to the localization of these reactions. An increase in ohmic conductivity at 10^4 Hz frequency was found in hepatic tissue as well as a thickening and breakdown of double lipoprotein membranes as revealed by an electron-microscope study of ultrathin slices of tissues of mice irradiated with lethal doses of γ radiation. According to our model, the primary oxidation reactions of the lipid part of the lipoprotein complex are localized along the ionization column propagating concentrically in the plane of the lipoprotein and being accompanied by its breakdown. (auth)

38871 ON THE EFFECT OF PROPHYLACTIC COMPOUNDS IN INTERNAL AND EXTERNAL IRRADIATION OF ANIMALS. L. L. Khamaide and A. S. Mochalina. p.127-31 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

The prophylactic effect of beta-mercaptoethylamine was followed up in external (γ rays of Co^{60}) and internal (Ce^{144}) irradiation of animals. The results are presented as follows: (1) systematic observations on the general condition of the irradiated mice and their survival rate; (2) changes in weight of radiosensitive organs, such as the spleen and liver, and (3) hemolytic properties of the liver of shielded and control mice at various post-irradiation time intervals. It follows from the results obtained that beta-mercaptoethylamine when administered prior to external irradiation with γ rays of Co^{60} exerts a favorable effect, whereas the same agent when combined with the incorporation of Ce^{144} enhances the injury caused by the ionizing factor. (auth)

38872 FUNCTIONAL APPROACH TO THE EXPLANATION OF THE RELATIVE BIOLOGICAL SIGNIFICANCE OF NUCLEAR VERSUS CYTOPLASMIC RADIATION LESIONS. (GENETIC THEORY OF THE RADIATION DISEASE). B. L. Astaurov. p.140-61 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

Experimental data in which nuclear vs. cytoplasmic radiation lesions can be examined and evaluated separately are discussed. Experiments in which cytoplasm and nucleus were separately exposed to ionizing radiation not only confirm the paramount biological importance of nuclear lesions but in some cases also provide a direct and definite proof of the fact that changes induced in the cytoplasm play a comparatively insignificant role in the total damaging effect. It is to be expected, therefore, that the transition from uniqueness to multiplicity of nuclear elements, i.e., from haploidy through diploidy to polyploidy in microorganisms, plants, and animals will be accompanied by a gradual decrease of such radiation effects as impeded growth and development of radiation disease and death. The conclusion drawn from all the data discussed is that the manifold biological effects of radiation are mostly due to initial destructive changes in the genetic elements of cell nuclei accompanied by their disfunction in the processes of constructive biosynthesis. (A.G.W.)

38873 ON THE HIT-PRINCIPLE IN RADIOBIOLOGY. N. V. Timofeev-Ressovskii. p.162-73 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

A critical review is presented from a definitely positive viewpoint of the history, present status, and the importance of the hit principle and the target theory in radiobiology. This is supplemented by a short phenomenological description of the elementary physical initiating mechanisms and a discussion of the connections between the mechanisms of elementary radiobiological reactions and some general principles of biology. (auth)

38874 ON THE MECHANISM OF BIOLOGICAL ACTION OF RADIATIONS AND ON THE NATURE OF THE REACTIONS OF THE LATENT PERIOD. N. V. Luchnik. p.174-80 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

The mechanisms of biological action of ionizing radiations are still largely obscure. The only quantitative theory was the target theory based on the hit principle. During the last decade there was a tendency to deny the importance of the hit principle in view of the ever-increasing amount of facts showing a marked dependence of the radiobiological effects on various factors. Experiments led to the following conclusions concerning the mechanism of cytogenetic effects of radiation. The primary injury consists in a local reversible inhibition of the autocatalytic activity of chromosomes. At the time of chromosome reproduction this injury may result in a defective synthesis of a daughter chromosome that appears in mitosis as a chromatid break. From the biophysical point of view it may be said that local injury (caused by direct action) produces only a predisposition to mutation. For the realization of the injury extrachromosomal systems and environmental conditions are of decisive importance. This hypothesis explains the available facts better than others. Mathematical treatment of the time-effect curves is considered. Frequently such curves reflect statistics of the process, rather than of the objects. Because amplification of the primary injury proceeds through a process of transmission of hereditary information, possible interrelations between the hit principle and the information theory are briefly discussed. (auth)

38875 THE ROLE OF THE PLOIDY FACTOR IN RADIATION INJURY WITH REFERENCE TO THE GENETIC EFFECT OF IONIZING RADIATION. V. I. Korogodin. p.181-8 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

The role of the ploidy factor in the radiation injury of unicellular organisms is discussed as well as the significance of various types of genetic derangements of the cells of the germinal epithelium and gamates in the genetic effect of irradiation of higher animals. The degree of harmfulness of various types of mutations is analyzed with reference to the effect upon human populations of an increased radiation background. Some computations of the

dose which doubles the mutation frequency are presented. (auth)

38876 A STUDY OF THE SUCCESSIVE EFFECT OF ROENTGEN RAYS AND TEMPERATURE UPON THE FREQUENCY OF MUTATIONS AND ROENTGENOMORPHOSES. K. V. Vatti. p.189-93 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

Experimental evidence is brought forward on the successive effect of roentgen rays and temperature upon the mutation and morphoses frequency in Drosophila. It was shown that additional treatment with high temperature results in a considerable increase of the mutation and morphoses frequency exceeding the sum of the effects of these factors individually. The question is discussed of the presence after irradiation in the immature germ and somatic cells of a reversible state of increased sensitivity (after-effect) so that weak additional treatment greatly enhances the genetic and biological effect of irradiation. (auth)

38877 THE EFFECT OF ROENTGEN RAYS AND OF HIGH TEMPERATURE UPON THE CROSSING OVER PROCESS. I. A. Zakharov and S. G. Inge-Vechtomov. p.194-7 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

A comparative study of the effect of roentgen rays and of high temperature upon the crossingover frequency in the centromere region of chromosome III of Drosophila melanogaster females showed that these agents call forth crossingover at different stages of oogenesis. High temperature proved to be a factor specific only to one stage, presumably the moment of chromosome conjugation (prophase of the first maturation division), whereas roentgen rays induce crossovers in cells both in the prophase of the first division and in the preceding stages. It is suggested that roentgen rays call forth some changes in the chromosomes of the oogonia that convert into chromosome exchanges when the cells reach the prophase stage of the maturation division. High temperature and roentgen rays act independently of one another. (auth)

38878 AFTER-EFFECT OF ROENTGEN RAYS UPON PRIMARY NON-DISJUNCTION OF X-CHROMOSOMES. M. M. Tikhomirova. p.198-202 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

The question of whether the radiation effect is confined only to the recorded genetic effect observed under ordinary conditions or whether there arise in the cells potential changes revealed only upon additional treatment is discussed. The frequency of primary non-disjunction of X-chromosomes was followed up for Drosophila irradiated with 3000 r and subsequently exposed to +37° during 8 hours after various time intervals. It is concluded that the phenomenon of radiation after-effect upon the disjunction of chromosomes does exist. (auth)

38879 THE EFFECT OF POLYPLOIDY UPON RADIATION AFFECTION OF WHEAT CELLS. N. A. Ismozherov. p.203-6 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

The effect was followed of the degree of polyploidy upon the inhibition of mitotic activity and the number of chromosome mutations elicited by gamma irradiation of dry wheat seeds. It was shown that polyploidy had no effect upon the inhibition of mitotic activity caused by irradiation. The number of primary lesions of chromosomes per cell increased directly with the degree of ploidy. The rate of recovery of primary lesions is somewhat higher in polyploids. (auth)

38880 ON THE MECHANISM OF ACTION OF HUMIDITY UPON RADIOSENSITIVITY OF SEEDS. N. A. Poryadkova. p.207-12 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

Dormant pea seeds with varying water content (from 4% to about 20%) were irradiated with 15,000 r gamma rays of Co^{60}. Radiation injury (measured as survival of seedlings, their fresh weight, and number of chromosomal bridges and fragments) decreases with increasing water content. In cytological experiments it was possible to differentiate the influence of humidity on the amount of primary injury from its influence on the fate of the injury. It appears that primary injury is independent of the water content. Increasing humidity increases the rate of recovery of primary potential lesions. (auth)

38881 THE POSTIRRADIATION EFFECT OF PROTECTIVE COMPOUNDS UPON FREQUENCY OF CHROMOSOME ABERRATIONS. L. S. Tsarapkin. p.213-17 of "Pervichnye Mekhanizmy Biologicheskogo Deistviya Ioniziruyushchikh Izluchenii." Moscow, Publishing House of the Academy of Sciences, 1963.

Treatment of dry pea seeds with cysteine solutions after irradiation with γ rays greatly reduced the number of chromosome aberrations in the root meristem as compared with seeds moistened with water. Most affected by cysteine treatment is the number of fragments, and less affected is the number of bridges. The effect is due to a decrease in the number of injured cells. The protective action is manifested within a wide interval of cysteine concentrations, but the latter should be applied from the very beginning of moistening. A study of the kinetics of the process showed that the effect of cysteine is mostly confined to the first mitosis in increasing the rate of recovery of potential injuries. With all doses tested cysteine calls forth a similar effect. Cysteine, alanine, serine, sodium chloride, sodium acetate, and ethanol affect the rate of recovery and frequency of chromosome aberrations to the same degree as cysteine. ATP and 2,4-DNP are more active than cysteine while glucose greatly increases the number of injured cells and fragments. The cytogenetic effect is due to two factors, viz., local chromosome injury and a more general cell injury which influences the probability of manifestation of the injuries. (auth)

38882 HISTOLOGY, NATURAL HISTORY AND RESULTS OF TREATMENT OF SALIVARY GLAND TUMOURS. Margaret D. Snelling (Middlesex Hospital, London and Marie Curie Hospital, London). 26p. (CONF-162-1)

From American Radium Society 45th Annual Meeting, San Francisco, Apr. 1963.

The histology and treatment of tumors of the palate, tonsil and peritonsillar region, lateral pharyngeal wall, nasal cavity, nasopharynx, and sinuses observed between the years 1928 through 1962 are discussed. Techniques used at the Middlesex Hospital in London are described. It is believed that an intensive first treatment by surgery or radiotherapy or by a combination of both is essential for success in the treatment of the tumors and that the treatment policy must be decided and reviewed at a combined clinic attended by surgeons and radiotherapists. In all cases supervoltage techniques are used and the dosage of

5000 to 6000 rads is given over about 6 weeks to the mixed parotid tumors, while the cylindromas receive 6000 to 7000 rads over a period of 6 to 8 weeks. (P.C.H.)

Radiation Sickness

Refer also to abstracts 39351 and 39354.

38883 (BNL-6698) HUMAN RADIATION INJURY — A CORRELATION OF LEUKOCYTE DEPRESSION WITH MORTALITY IN THE JAPANESE EXPOSED TO THE ATOMIC BOMBS. George J. Jacobs, Francis X. Lynch, Eugene P. Cronkite, and Victor P. Bond (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT-30-2-GEN-16. 18p.

Data collected by the Atomic Bomb Casualty Commission and the Japanese data of 1945 were reevaluated to see whether the leukocyte count at various time intervals reliably prognosticates death survival. There is a good correlation between death and depression of the leukocyte count taken during the third to fifth week after exposure. The correlation is perhaps best for counts taken during the third week. Leukocyte counts less than 3000 are not so hazardous in the fourth and fifth week as in the third week. It is believed that the leukocyte count is the best single indicator of severe radiation injury, and that electronic methods of counting leukocytes should be made available to assist in casualty sorting and direction of therapy. (auth)

38884 (BNL-7274) HEMATOLOGICAL EFFECTS OF WHOLE-BODY IRRADIATION. T. M. Fliedner and E. P. Cronkite (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 26p. (CONF-150-2)

From Congress of Science on Humans, 2nd Annual Conference, New York, June 1963.

The acute effects of ionizing radiation on blood cell formation in man are reviewed. Data are summarized on 46 persons who received radiation exposure in excess of the maximum permissible annual dose. Four of these persons died as a consequence of overexposure to radiation. The hematological findings in these persons are presented. Diagnosis of radiation injuries based on hematological findings is discussed. Procedures are outlined for the management of persons exposed to radiation doses in the near-lethal range. (C.H.)

38885 (SAM-TDR-63-40) POSTIRRADIATION HYPERGLYCEMIA IN THE PRIMATE. Donald R. Anderson, Alexander Hernandez-Diaz, and Frances A. Quinn (School of Aerospace Medicine, Brooks AFB, Tex.). June 1963. 4p. (CONF-217-1)

From Radiation Research Society 11th Annual Meeting, Milwaukee, May 1963.

Alteration in carbohydrate metabolism resulting from radiation exposure is extensively reported in the literature. Plasma glucose evaluation in rats was found to reach a maximum at 2 to 4 days postirradiation. In other species the level of liver glycogen increased after irradiation. In a study of changes of serum composition following acute radiation in the Macaca mulatta primate, a marked hyperglycemia was observed within 30 min. At 2 hr the glucose level was considerably reduced and was essentially normal at 4 hr post-irradiation. To relate this phenomenon with other species previously reported, rats were irradiated; they did not respond to this immediate glucose burst. Serum response of the rabbit and the dog also failed to demonstrate this very early hyperglycemia. Additional monkeys were then irradiated and in a program utilizing chemical protective compounds it was observed that the preadministration of certain protective materials modified the hyperglycemic response. (auth)

38886 (UCRL-11014) DIFFERENCE IN INJURY MODE, DOSE-RATE DEPENDENCE, AND RBE OF 730-Mev PROTONS, 100-kvp X RAYS, AND 250-kvp X RAYS. James K. Ashikawa, Charles A. Sondhaus, Cornelius A. Tobias, Ann G. Greenfield, and Vally Paschkes (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 13, 1963. Contract W-7405-eng-48. 23p. (CONF-205-2)

From International Atomic Energy Agency Symposium on the Biological Effects of Neutrons Irradiation, Upton, N. Y., Oct. 1963.

Mortality at 6, 12, and 30 days was studied in male Swiss Webster white mice exposed to 730-Mev protons, 200-kvp x rays, and 100-kvp x rays at different dose rates. In the proton-irradiated mice, 6- to 8-day gastrointestinal death predominated at both 100 and 1000 rad/min, and was enhanced at the higher dose rate. In the x-ray exposures, 12- to 14-day hematopoietic death predominated and showed a similar dose-rate effect. The RBE for 30-day LD_{50} was found to be 0.8; the RBE for 6-day LD_{50} was found to be 1.2 at the same dose rate of 100 rad/min. It is suggested that the difference in injury mode may be due to differences in tissue dose distribution. The higher but variable proton RBE for 6-day gut death appears to exhibit the dose-rate effect associated with low-LET exposure. Practical consequences of the dose distribution and dose-rate factors are discussed. (auth)

38887 (UCRL-11015) PHYSICAL PARAMETERS IN EXPOSURE OF LARGE ANIMALS TO HIGH-ENERGY PROTONS. Charles A. Sondhaus, Roger W. Wallace, John T. Lyman, Kenneth W. Kase, and Palmer G. Steward (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 13, 1963. Contract W-7405-eng-48. 29p. (CONF-205-3)

From International Atomic Energy Agency Symposium on the Biological Effects of Neutrons Irradiation, Upton, N. Y., Oct. 1963.

Calculations predict that a beam with intensity profile suitable for large-animal exposures will be produced by multiple Coulomb scattering of the 730-Mev proton beam of the 184-in. cyclotron. Degradation of proton energy to about 50 Mev appears feasible although the resulting dose rate may be low. By rotating an animal to simulate omnidirectional exposure, depth-dose patterns similar to those predicted for solar flare proton energy spectra can be produced. Beam intensity and depth dose were calculated for several proton energies and several diameters of spherical phantom as a preliminary step to experimental study. These results are presented. (auth)

38888 (UR-631) POPULATION DENSITY AND SURVIVAL OF THE X-IRRADIATED MALE RAT. E. W. Hahn (Rochester, N. Y. Univ. School of Medicine and Dentistry). Aug. 21, 1963. Contract W-7401-eng-49. 6p.

The data suggest that population density does not influence the rate or per cent survival of male rats following a single whole-body exposure of 600, 750, and 900 r. This is contrary to data reported on x-irradiated female rat populations. (auth)

38889 ON THE INFLUENCE OF THIOPHENE-2-CARBONIC ACID N-PHENYLAMIDINE ON THE BONE MARROW CHANGES IN ACUTE RADIATION DISEASE. D. G. Zographov and I. A. Baev (Inst. of Radiobiology,

Sofia). Acta Biol. Med. Ger., 8: 337-43(1962). (In German)

Histologic examination of bone marrow was conducted for 30 days in rats exposed to a 650-r, whole-body dose of 180-kv x rays. Some rats were injected 5 min before exposure with 5 mg/kg of thiophene-2-carbonic acid N-phenylamidine compound, dissolved in a 1% solution of acetic acid at pH 5. The total mitotic index of myelocytes reached an earlier (5th day), higher max (14%) in the injected rats than in rats receiving only irradiation (10th day, 10% in comparison with a control index of 5%). This index fell on the 1st day in untreated and rose in treated animals. The maturation indices in treated and untreated rats were 1.5 and 2.3 for granulocytes and 14 and 19 for erythroblasts on the 1st day postirradiation; their subsequent changes were similar in the 2 groups. The marrow content of blood cells and their precursors fell to a min on the 5th day in both groups, to 33% of the total cells in the treated rats and 17% in untreated rats. The recovery as reflected in this value was greater in the treated animals. The postirradiation fall was less marked in the treated group with respect to lymphocytes, megakaryocytes, granulocytes, and erythroblasts. It is concluded that this compound protects radiosensitive myelocytes from the initial radiation damage but has no direct action per se on hematopoiesis. (BBB)

38890 ASEPTIC INFLAMMATION IN THE LUNGS IN ACUTE RADIATION SICKNESS. A. E. Ivanov. Federation Proc., Transl. Suppl., 22: Pt. II, T850-4(Sept.-Oct. 1963).

Inflammation in the lungs of irradiated rabbits at the site of turpentine injection has much in common with the inflammatory changes arising in other tissues and organs during local irradiation or acute radiation sickness. The fact that the inflammatory changes under different conditions of irradiation are similar in type regardless of the character of the inflammatory agent suggests that the phenomenon has a common mechanism. The absence of polymorphonuclear (eosinophilic) leukocytes from inflammatory foci in irradiated rabbits is due not only to the developing leukopenia, but also to a disturbance of the leukocyte emigration process into the inflammatory focus. In irradiated rabbits in contrast to the controls, the normal arrangement of the fibrous structures is preserved in the necrotic lung tissue at the site of turpentine injection. In animals with severe acute radiation sickness induced by external irradiation in sublethal doses, the ability of the organism to respond to introduction of an inflammatory agent by an increase in the number of leukocytes in the blood and by a rise of the body temperature is to some extent preserved. (auth)

38891 CLINICAL OBSERVATIONS ON CATTLE EXPOSED TO LETHAL DOSES OF IONIZING RADIATION. D. G. Brown. J. Am. Vet. Med. Assoc., 140: 1051-5(1962).

Animals 3 to 5 years old were exposed to single doses of whole-body irradiation from 450 to 700, which corresponded to a 50 to 100% lethal dose. In addition the body temperature and blood values were registered. The first climbed steeply after a short initial fluctuation until the end of the second week after irradiation and fell, except in the death cases, to normal in about 5 days. The studies of the blood showed the known and promptly beginning leukocyte decrease with later blood platelet fall (minimum at end of the fourth week). At this point of time corresponding bleeding appeared. The surviving animals recovered spontaneously, achieving their normal values, however, in only about a year. The descendants of the irradiated animals have suffered as yet no damages, and hardly any malformations have appeared. The effects of radiation in this regard seem to depend less on species than on individual peculiarities. (Atomdokumentation, 5: No. 7, Apr. 1963)

38892 ACTION OF CYTOTOXIC SERUMS ON WHOLE-BODY Co^{60}-IRRADIATED ANIMALS. II. HISTOLOGIC FINDINGS. E. Benassi, F. Piccotti, G. L. Sannazzari, and A. Torretta (Università, Turin). Minerva Fisioterap., 7: 295-300(Nov.-Dec. 1962). (In Italian)

In the first report of this series it was shown that the lethal effect of whole-body Co^{60} γ irradiation of guinea pigs was accentuated by subsequent injection of cytotoxic antiserum. The antiserum was prepared by intravenous injection of rabbits with a suspension of guinea pig lymphoid cells, which gave titers up to 1:128. Histologic changes in the lymph nodes are reported for these guinea pigs, which were irradiated with 200, 400, or 600 r and injected intraperitoneally with 0.25 ml of this antiserum every 3rd day postirradiation. About 30% of unirradiated animals so injected died within 30 days, presumably on account of anaphylaxis, showing congestion and eosinophil infiltration of spleen and other lymphatic tissues. Injection of cytotoxic serum after 200 r resulted in 100% mortality by 21 days whereas normal rabbit serum after 200 r caused only 20% 30-day mortality. The respective rates after 400 r were 100% at 18 days and 60% at 30 days, and after 600 r, 100% at 8 days and 100% at 30 days. In animals injected with an antiserum and irradiated with 400 or 600 r, complete destruction of the spleen was evident by the 6th to 8th day, which was followed by fibrotic replacement. These changes were much more severe and rapid than after irradiation alone. The results indicated that panirradiation at doses of 200 r and above markedly inhibits the defense mechanisms of the guinea pig against cytotoxic serum, allowing the anticellular antibodies contained therein to augment the injurious action of radiation on lymphoid cells. (BBB)

38893 HOMOLOGOUS TRANSPLANTATION OF HEMATOPOIETIC TISSUES AND ITS EFFECT UPON RADIATION INJURY. Fumio Hirose (Hiroshima Univ.). Nippon Ketsueki Gakkai Zasshi, 24: 689-701(1961). (In Japanese)

Group-bred ddN (CLEA) mice of both sexes 5 to 6 weeks of age were exposed to a single whole-body, 600- or 800-r dose of x rays immediately after homologous bone marrow and lymphatic tissue (thymus, lymph node, and spleen) had been transplanted either singly or in combination. Exposure to 800 r resulted in death of all untreated animals by the 13th day after irradiation. Separate transplantation of bone marrow and spleen, as well as the combined transplantation of bone marrow and spleen, or bone marrow and thymus, prevented acute radiation death but separate transplantation of thymus and lymph node, or combined transplantation of bone marrow and lymph node, did not. Bone marrow transplantation was very effective in animals 7 months old but had little effect in animals 5 to 6 weeks old. Bone marrow transplantation was much more effective than spleen transplantation in 7-month-old animals but little difference in effect was found in the younger animals. Combined transplantation of bone marrow and thymus was highly effective when thymus cells were comparatively few, whereas it was ineffective when thymus cells were present in large numbers. Exposure to 600 r resulted in hyperplasia of medullary hematopoietic tissues at a later stage in nontransplanted controls. Thus, a blood picture and histologic pattern similar to that in myeloid leukemia were seen in animals sacrificed 90 days after irradiation. In groups in which bone marrow transplantation had been made, however, inhibition of medullary hematopoietic hyperplasia was seen. It was concluded that not only repopulation of hematopoietic tissue following homologous transplantation in-

hibits hyperplastic hematopoiesis in the recipient, but also immune reactions may contribute to the inhibition. (BBB)

38894 BONE MARROW TRANSPLANTATION STUDIES IN MICE LETHALLY IRRADIATED UNDER HIGH DOSE RATE. Haruto Uchino and Morihisa Yamagishi (Kyoto Univ.). Nippon Ketsueki Gakkai Zasshi, 24: 656-67(Dec. 1961). (In Japanese)

When dd/s mice were exposed to 900-r, whole-body Co^{60} γ radiation (42 r/sec) and transplanted with isologous bone marrow, a 40 to 100% 30-day survival was noted. Hematologic and histologic studies as well as those using radioisotope tracers revealed that the high survival rate was due to early and rapid recovery of hematopoietic function. Usually 10 million nucleated bone marrow cells were transplanted. When the nucleated cell number was increased to 20 million, isologous marrow transplantation even 6 days after irradiation still gave a survival rate >30%. Decreasing the amounts down to 100,000 still gave ~45% 30-day survival. Homologous bone marrow transplantation after lethal irradiation also gave good (30 to 70%) 14-day survival, followed by rapid increase of death rate. Histologic study revealed that recovery of cells of erythrocytic and myelocytic series occurred early, but that of lymphatic tissue was retarded. Recovery of lymphatic tissue became apparent only after 40 to 50 days postirradiation. Homologous marrow transplantation 1 or 2 days after irradiation seemed better in obtaining good 14-day survival than transplantation immediately after irradiation. Increasing the bone marrow dose up to 20 million nucleated cells was not effective in obtaining good initial survival. Transplantation studies of chimeric bone marrow showed the possible existence of homologous marrow in host mice both at 20 days and 8½ months after transplantation. Successful transplantation of heterologous (rat) bone marrow was not obtained. When aminoethylisothiuronium was given to the host followed by otherwise supralethal (1500-r) irradiation, successful transplantation of homologous bone marrow seemed to be facilitated. Its use in bone marrow donors, combined with irradiation, may be of value, it is suggested, to prevent secondary disease in view of reports that AET protects mainly nonantibody-forming cells. Delayed effects of radiation injury (shortening of life span, retarded body wt increase, and increased incidence of nephrosclerosis and focal myocardial calcification) were seen in the lethally irradiated mice treated with isologous bone marrow. (BBB)

38895 ON CHEMICAL AND BIOLOGICAL PROTECTION AGAINST IONIZING RADIATIONS. Giuseppe Solarino and Donato Fumarola (Università, Bari, Italy). Progr. Med., 17: 620-37(Sept. 30, 1961). (In Italian)

This is an extensive review of radioprotective agents covering 239 previously published articles. Chemical agents are discussed according to those acting by tissue anoxia, as sulfhydryl group donors, and by other mechanisms. The biological agents considered include hormones, vitamins, antibiotics, serum factors, and activators of the reticuloendothelial system. (BBB)

38896 BEHAVIORAL EFFECTS OF IONIZING RADIATIONS: 1955-1961. Ernest Furchtgott (Univ. of Tennessee, Nashville). Psychol. Bull., 60: 157-99(Mar. 1963).

The pertinent literature is comprehensively reviewed and over 200 references are cited. General conclusions reached on the basis of this survey are summarized. Prenatally irradiated mammals exhibit behavior patterns that may be best described as fearfulness, as well as a variety of other behavioral deviations, confirming that the developing nervous system is highly radiosensitive. It is apparent that doses up to several thousand roentgens do not interfere with learning of relatively difficult problems whenever radiation malaise or motivational changes do not inhibit performance. Actually, the evidence points in the other direction, i.e., that in many types of problems irradiated animals learn more rapidly than do controls. The simplest explanation of the superior learning in irradiated animals takes into account their decreased distractibility and narrow focus of attention. Ionizing radiations do not produce losses in learned habits if performance is tested soon after irradiation or within a few months afterwards. Drive, as a major determinant of performance, is influenced by homeostatic mechanisms, and when ionizing radiations affect these, performance may be altered. It has been shown that low doses of x rays are visible, and visual functions, especially scotopic, are depressed by ionizing radiations. It is assumed that the photochemical processes in the receptors are affected. Radiation-induced changes have also been reported for hearing, taste, and smell, but the findings have been equivocal, including reports of enchanced, lowered, or unaffected sensitivity. So far no good evidence is available for morphological changes in the nervous system in organisms irradiated in adulthood. A variety of behavioral symptoms occurs in the acute phases of radiation illness, but on the human level only qualitative data are available. It has been assumed that radiation induces or mimics aging, yet on the behavioral level there are only limited data bearing on this hypothesis. (BBB)

38897 EFFECT ON RADIATION LEUKOPENIA OF TISSUE EXTRACTS FROM ORGANS RICH IN RETICULOENDOTHELIAL TISSUE. L. Vaskov. Rentgenol. i Radiol., 2: 44-8(Apr.-June 1963).

Studies were made on the effects of Sarvinal Bayer, a protein-free extract of tissues having a high content of RET elements, on 139 rats including controls and animals receiving single and fractionated doses of 500 r air. Data indicate definite protective and therapeutic effect on leukopoietic elements. (OTS)

38898 ON CHEMICAL AND BIOLOGICAL PROTECTION AGAINST RADIATION INJURY. III. EFFECTS OF ADMINISTRATION OF OROTIC ACID ON ACUTE AND CHRONIC RADIATION SICKNESS. Donato Fumarola and Romeo Pantaleo (Università, Bari, Italy). Riv. Biol., 55: 261-72(July-Sept. 1962). (In Italian)

The possible protective effect of orotic acid was tested in rabbits subjected to lethal (2000-r) whole-body x irradiation and to chronic doses of 100 r/day. In the acute experiments the potassium salt or orotic acid was given in daily doses of 100 mg/kg/day for 10 days preceding irradiation and in chronic experiments the same doses were given daily with radiation until death. The acutely irradiated controls all died between the 3rd and 6th hr, with a median survival time of 4.3 hr. Orotic acid treatment prolonged survival to the 4th to 196th hr (median 119 hr). After daily 100-r doses, all the controls were dead by the 24th day (median 20 days), whereas the treated rabbits survived as long as 41 days (median 36). Additional experiments showed orotic acid to be moderately protective when given in a single dose 30 min after a lethal radiation dose but only slightly effective when administered 1, 2, or 3 hr postirradiation (none of the animals survived beyond 24 hr after 2000 r). In view of the depolymerizing action of ionizing radiation on nucleic acids, it is postulated that this compound, acting as a precursor of pyrimidine bases, facilitates the resynthesis of nucleic acids damaged by radiation. (BBB)

38899 WOUND HEALING IN ACUTE RADIATION DISEASE TREATED WITH PROTEIC BLOOD SUBSTITUTE (EXPERIMENTAL INVESTIGATION). Yu. T. Gnedash. Sb. Nauchn. Rabot, Kievsk. Okruzhnoi Voennyi Gospital, No. 4, 19-39(1962).

The effect of the proteic blood substitute (PBS) on wound healing processes was studied in chinchilla rabbits exposed to overall x irradiation in doses of 600 and 1000 r. The investigations included the influence of different doses on wound healing and the potential effect of PBS on the radiation disease, and on wound healing. The reaction occurring after irradiation developed in four stages: primary general reaction, latent period, febrile period, and restoration. A primary reaction lasting 30 min to 48 hrs was observed in each of 5 series carried out, but as to the further development of the disease, three (600 r) and two (1000 r) groups could be differentiated according to clinical, hematological, and histological observations. In the first group (slight radiation disease), the ratio of treated to untreated animals was 2:1. In the second group (moderate radiation disease), the latent and clinical stages were retarded in the case of rabbits treated with PBS. In the third group (serious radiation disease), the latent stage was absent, and the survival rates of treated and untreated animals differed greatly. Animals irradiated with 1000 r could be divided into two groups, which were almost consistent with the second and third groups after 600-r irradiation. The lifetime of animals treated with PBS doubled after irradiation, and their survival rate trebled as compared to that of untreated rabbits. The hemoglobin content and the number of thrombocytes and erythrocytes in all animals treated with PBS decreased more gradually. This process was accompanied by quicker restoration. Thus, the administration of PBS stimulated not merely the hemopoietic system but the entire organism. The radiation disease was the more serious, the slighter the leukocytosis during the primary reaction. Wound healing was better in some groups than others. A detailed histological description based on examinations at short intervals is given for all groups. In the two series of untreated rabbits, regressive changes depending on the seriousness of the disease predominated in the granulation tissue. Reparative processes set in only after the end of the disease and were the more vigorous, the stronger the effect of irradiation. The number of leukocytes in the wounds of animals treated with PBS increased rapidly, giving rise to phagocytosis. Wound infections diminished, and thus the healing conditions improved considerably. (TCO)

38900 ON THE QUESTION OF THE EFFECTIVENESS OF RADIATION PROTECTION SUBSTANCES IN TISSUE CULTURES. Karl Peters (Universität, Tubingen, Ger.). Strahlentherapie, 121: 599-612(Aug. 1963). (In German)

The radiation protective effect of several substances was investigated in vitro using fibroblasts of mice. Mitoses indices, numbers of pathological mitoses, of cytolyses, and of nuclear pyknoses as well as the judgement of the adhesion ability of the cells were used as criteria. Radiation protection effect in vitro was found with serotonin, pyridoxal-5-phosphate, and cysteamine in small concentrations. 3-adenosinmonophosphate and histamine-dihydrochloride were conditionally radiation protective. Adenosintriphosphate was without effect. A toxic effect was found for 5-adenosinmonophosphate, pyridoxine, and pyridoxamine. (auth)

38901 ON THE INDUCTION OF LATE INJURIES BY CHRONIC EXTERNAL ACTION OF SMALL RADIATION DOSES. Hanns Langendorff (Universität, Freiburg i. B.). Strahlentherapie, 122: 1-15(Sept. 1963). (In German)

A survey was made of the relation between radiation dose and late somatic radiation effects such as changes in the blood picture, induction of leukemia, tumor growth, shortening of life, and disturbances in fertility. It was found that a relatively large total radiation dose is required to produce a barely recognizable, irreversible late radiation effect when given as a series of small doses. Since there are relatively few references that deal with the described problems and using animal experiments almost exclusively, it is assumed that the present findings are not sufficient to make detailed statements about the extensiveness of the risk of damage during the chronic influence of small amounts of ionizing radiation on humans. (auth)

38902 ON THE EFFECTS OF FRESH AND DEEP-FROZEN PRESERVED ISOLOGOUS BONE MARROW ON THE HEMATOLOGIC RADIATION SYNDROME AFTER LETHAL WHOLE-BODY IRRADIATION OF RATS. Siegfried Witte, Gunther Barth, Herbert Graebner, and Norbert Henning (Universität, Erlangen-Nuremberg and Universität, Gissen, Ger.). Strahlentherapie, 122: 48-55 (Sept. 1963). (In German)

Thirty-five white rats (Sprague-Dawley) were total-body irradiated with 1000 r Co^{60} γ rays. The effect of an isologous bone marrow cell transfusion (2.5×10^6 cells/100 g, given intravenously 24 hr after the irradiation) upon the hematologic radiation response was investigated. Except for one control group, which received no marrow cell transfusion, the animals received either freshly taken or preserved (at −70°C in dimethyl sulfoxide) bone marrow. With this, the fatal results of the total-body irradiation could be inhibited consistently. Body weight showed a continuous increase 5 days after the radiation application in the animals treated with bone marrow. The control group developed rapidly anemia, leukopenia, and thrombopenia which remained stationary until death. After bone marrow transfusion the blood cell values were normalized within about 4 weeks. Leukopenia lasting 2 to 3 weeks could not be inhibited even by administration of marrow cells. A transient anemia was found in the animals which were treated with fresh bone marrow but not after injection of the cells preserved in dimethyl sulfoxide. The primary thrombocyte decrease could be inhibited by administration of native cell suspension. Using preserved material the thrombocytes had apparently lost their viability but thrombopoiesis by the megakaryocytes was probably still present. (auth)

38903 NEW HEMATOLOGIC FINDINGS IN RATS AFTER WHOLE-BODY IRRADIATION. Gerhard Ruhenstroth-Bauer, Johannes G. Gostomzyk, and Rudolf Arnold (Max-Planck-Institut für Biochemie, Munich). Strahlentherapie, 122: 56-67(Sept. 1963). (In German)

Bone marrow of rats taken after x irradiation showed, in vitro, a decreased P^{32} incorporation compared to normal bone marrow. The extent of inhibition depends upon the radiation dose and the time of taking the marrow after the irradiation. If the bone marrow is taken 1 to 2 hr after irradiation with 800 r, the incorporation rate is decreased by 40 to 50%; marrow taken 5 to 6 hr after irradiation has a normal phosphate incorporation; 1 to 4 days after the irradiation the incorporation rate is increased. One hour after irradiation with 800 r a factor that increases in vitro the P^{32} uptake into the normal bone marrow can be found in the plasma of rats. Two hours after irradiation the leukocyte counts in the blood decrease and reach minimum values

after 24 hr. Immediately after irradiation, a fraction of rapidly moving leukocytes appears in the hemocytopherogram. These are probably membrane immature granulocytes. After a few hours these electrophoretically rapidly moving cells disappear and normal granulocytes appear again. The ratio of rapidly moving leukocytes to granulocytes depends on the radiation dose and the time of investigation after irradiation. (auth)

38904 CHANGE OF THE OXYGEN CONSUMPTION OF RATS UNDER X-RAY WHOLE-BODY IRRADIATION. Klaus-Werner Schneider and Heribert Braun (Medizinische Universitätsklinik, Wurzburg, Ger.). Strahlentherapie, 122: 76-82(Sept. 1963). (In German)

The influence of total-body x irradiation on O consumption was investigated in rats. A Noyon-Diaferometer was used for the measurements. The greatest reduction was observed 3 to 6 hr after irradiation, while an increase of the values could be observed 22 hr later. Since an increase in hematocrit values could not be found, the reduction of O consumption for the dosage administered is not accompanied by a classical shock syndrome. The relation between shock and O consumption, discussed in the literature, is pointed out. (auth)

38905 INFLUENCE OF THE TIME BETWEEN IRRADIATION AND FERTILIZATION ON THE F_1 GENERATION OF MICE. Felix Wachsmann, Armin Utreras, and Erika Schreiner (Universität, Erlangen-Nuremberg). Strahlentherapie, 122: 91-102(Sept. 1963). (In German)

Damage to the gonads lasting at least 4 to 6 weeks appeared in female as well as in male mice after single short term x irradiation of the gonads with 400 r. The number of the dominant lethal mutations was used as test. The greatest effect was observed at the end of the 2nd week. The decrease of fertility reached a maximum during the 5th week in both sexes. Female mice had a slower recovery. Malformations (exencephalias) were found which are understood to be true radiation-induced mutations. (auth)

38906 EXPERIMENT ON THE INCREASE OF RADIOPROTECTIVE EFFECTS OF SULFHYDRIL-GROUP-CONTAINING AMINO ACIDS BY SURFACE-ACTIVE SUBSTANCES. Erwin Magdon (Medizinisch-Biologische Forschungszentrum der Forschungsgemeinschaft, Deutschen Akademie der Wissenschaften, Berlin and Robert-Rössle-Klinik, Berlin). Strahlentherapie, 122: 103-11(Sept. 1963). (In German)

The experiments with surface-active substances showed that DMEA had no x-ray-protective effects, dispersal BO, ethyl alcohol and ABS only moderate, but E-30 yielded significant x-ray-protective effects. The radioprotective effects of AET and MEA were increased weakly by ethyl alcohol, but very strongly by BO and E-30. The x-ray-protective effect of thioctic acid described in the literature could not be affirmed. The influence of the surface active substances upon the x-ray-protective effects of AET could be explained by attempts with hyaluronidase, from which it was concluded that the advanced effectivity of the sulfhydril group-containing substances is due to a changed permeability. It is supposed that the cause of the intensification of the x-ray-protective effect by surface active substances must be seen in a variation of the uptake and distribution mechanisms of the sulfhydril group-containing substances. (auth)

38907 THE INFLUENCE OF INTENSIVE RADIATION THERAPY ON THE ISOAGGLUTININ CONTENT OF THE SERUM. UNDER SPECIAL CONSIDERATION OF THE BEHAVIOR OF RADIATION EFFECTS IN THE INTESTINAL REGION. Hans-Dieter Claus (Bergbaukrankenhaus, Erlabrunn Erzgebirge, Ger.). Strahlentherapie, 122: 137-48 (Sept. 1963). (In German)

A decrease in serum titer of isoagglutinins was observed in tumor patients after deep therapy. In separate tests in patients irradiated in the abdominal area and in patients irradiated in other regions, it was found that only the group where parts of the intestine were irradiated showed a statistically significant decrease of natural antibodies. This is felt due to hypoproteinemia from intestinal loss due to an increase in the permeability of the intestine after irradiation. From the results it might be assumed that intensive therapeutic irradiation in the area of the intestine produces to a certain degree the symptoms of an exudative enteropathy with a seepage of plasma proteins into the intestine. The direct and indirect radiogenic decrease of antibody production is apparently less than the enteral loss of the circulating antibodies. (auth)

38908 CHEMICAL PROTECTION OF THE ALIMENTARY TRACT OF X-IRRADIATED MICE. J. R. Maisin (CEN, Mol, Belg.). Strahlentherapie, Sonderbaende, 51: 250-9(1962). (BLG-170). (In English)

AET offered good protection to the gastrointestinal tract of whole-body x irradiated mice exposed to 1500 r by preserving from radiation damages a sufficient number of intestinal crypt cells that allow a good recovery of the small intestine mucosa. In the non-protected mice all measurements showed that on 4th day the small intestine mucosa was completely destroyed. At the same time, in protected mice all measurements were normal. Only the esterases, although the small intestine mucosa appeared histologically normal, did not recover completely by the 10th day. Moreover, it seems possible by giving 16 mg of AET orally, 5 minutes, or 4 mg 30 minutes before irradiation to protect selectively the small intestine against x irradiation damage. After a 1500 r x-ray exposure the small intestine mucosa showed a good recovery, but all mice developed a bone marrow syndrome and died by the sixth day. AET and the most active protective compounds were, however, not able to protect the small intestine of mice above 2500 r. (P.C.H.)

38909 MARROW TRANSPLANTATION IN NEWBORN MICE WITH HEREDITARY SPHEROCYTOSIS: A MODEL SYSTEM. Arno G. Motulsky, Ruth Anderson, Robert S. Sparkes, and Ralph H. Huestis (Univ. of Washington, Seattle). Trans. Assoc. Am. Physicians, 75: 64-72(1962).

A heritable bone marrow disorder, pathophysiologically identical to human hereditary spherocytosis was selected as a model system for investigation of the treatment of inherited marrow disease by hemopoietic homografts in the newborn period. Bone marrow suspensions were prepared from femur and tibia of adult normal donor and injected intravenously into the facial vein or retroorbital plexus of newborn spherocytic animals within 24 hr after birth. Successful replacement of pathologic by normal marrow was demonstrable in most recipients. Reticulocyte levels and osmotic fragility remained essentially constant for 1 yr following initial bone marrow transplants, indicating apparent stability of successful grafts. Skin grafts from the original bone marrow donors to the respective recipients were done between 3 to 6 months of age. Skin grafts between control animals were rejected in 2 weeks, indicating that histocompatibility genes differed between various individuals, but spherocytic individuals successfully trans-

planted with normal marrow maintained skin grafts up to 1 yr. The data show that immunologic tolerance conferred by marrow injections into the newborn extends to tissues other than the marrow. Several treated mice, not showing evidence of red cell changes, exhibited variable prolongation of skin graft survival, indicating that even in the absence of significant erythropoietic transplants some donor cells had been successfully transferred at birth and had induced partial tolerance. The mechanism by which the normal donor marrow replaces spherocytic erythropoiesis in the newborn is not known but could relate to seeding of relatively empty marrow cavities by the injected cells preventing the animal's own marrow cells from functional development. (TCO)

38910 PROPHYLAXIS AND TREATMENT OF RADIATION INJURY. Siegmund Schmidt. Z. Ges. Inn. Med. Ihre Grenzgebiete, 16: 414-23(May 15, 1961). (In German)

Immediate and long-term deleterious effects of radiation are discussed, and the preventative and therapeutic use of a wide variety of agents, including known radioprotective agents, vitamins, antibiotics, blood transfusions, bone marrow transplants, placenta and liver injections, Bogomoletz serum, beet juice, brewers' yeast, royal jelly, and algae, are reviewed. (BBB)

CHEMISTRY

General and Miscellaneous

38911 [CONFERENCE ON] MULTI-COMPARTMENT ANALYSIS OF TRACER EXPERIMENTS, [NEW YORK ACADEMY OF SCIENCES, MAY 9-11, 1962]. Ann. N. Y. Acad. Sci., 108: 1-338(May 10, 1963).

Twenty-five articles are included, separate abstracts were prepared for 4. One article on use of an analog computer in studies of Sr and Ca metabolism in man was previously abstracted in NSA. The remaining 20 articles include information on: application of linear analysis and hydrodynamic analogs and digital computer of multi-component systems; flow diagrams, transfer rates, multiple pool analysis, pattern of flow and sequential stages, digital computer simulation, localization, and mathematical aspects of multi-compartment analysis of tracer experiments; integral equation formulation of perturbation-tracer analysis; interpretation of tracer experiments under conditions of incomplete circulatory mixing; theorems on linear systems; linear network theory and tracer analysis; effects of circulatory beds on tracer experiments; transformation methods for tracer data analysis; resolution of decay curves using Fourier Transforms; and the rate of decarboxylation of mevalonic acid-1-C^{14} in man. (P.C.H.)

38912 THE INTEGRAL EQUATION REPRESENTATION OF REACTIONS IN COMPARTMENT SYSTEMS. Herman Branson (Howard Univ., Washington, D. C.). Ann. N. Y. Acad. Sci., 108: 4-14(May 10, 1963).

The application of integral equations and the relationship of the metabolizing and rate functions to parameters normally encountered in the differential equation description of the same system are discussed. It was thought that if a tracer experiment could disclose the metabolizing function for a system, then the complete equation for the normal substance could be solved for the rate function. The behavior of the system could be characterized, then, by these two functions, and changes due to shock, drug action, and the like would be reflected in altered forms of the two functions. (P.C.H.)

38913 AN EXTENSION OF THE DIFFUSION EQUATION TO INCLUDE CLEARANCE BY CAPILLARY BLOOD FLOW. William Perl (New York Univ., New York). Ann. N. Y. Acad. Sci., 108: 92-105(May 10, 1963).

A theory of heat and matter distribution in living tissues is presented for use where large-scale diffusion over millimeter distances is comparable in effect with small-scale diffusion, exchange, and convection over micron distances. The theory is in the form of a partial differential equation including the Fourier-Fick diffusion equation and Fick's perfusion principle in differential form. The theory is experimentally testable. It is compatible with Kety's radioactive tracer local clearance experiment and agrees at least qualitatively with steady-state experiments based on the use of Gibbs thermoelectric probe. The theory suggests an absolute method for determining capillary blood flow per unit volume by the transient response of a Gibbs thermoelectric probe to a sudden and temporary blood occlusion of the tissue. The possible significance and measurability of fluctuations in capillary blood flow are pointed out. (P.C.H.)

38914 A DIRECT ANALOG COMPUTER FOR MULTI-COMPARTMENT SYSTEMS. W. A. Higinbotham, R. M. Sugarman, D. W. Potter, and J. S. Robertson (Brookhaven National Lab., Upton, N. Y.). Ann. N. Y. Acad. Sci., 108: 117-21(May 10, 1963).

Description of a direct analog computer for multi-compartment systems is given. In multi-compartment analysis in the model-building stage the situation is completely reversed from the general commercially available analog computers with the answer being given (in the form of experimental data) and with the equations (the model) to be deduced. Operation of the computer is also discussed. (P.C.H.)

38915 AN ANALOG COMPUTER FOR THE GENERALIZED MULTI-COMPARTMENT MODEL OF TRANSPORT IN BIOLOGICAL SYSTEMS. Earle C. Gregg (Western Reserve Univ., Cleveland). Ann. N. Y. Acad. Sci., 108: 128-46(May 10, 1963). (TID-16964)

A technique for the determination of transfer rates and other parameters of biological systems is outlined. The technique is designed for the presentation of solutions to the generalized equations in order to: determine an appropriate model that produces the same results as observed experimentally; determine the parameters of a specific model that best fit the data; vary the boundary conditions easily for matching or predicting what a particular model will do under other experimental circumstances; use and observe transient effects between compartments (assuming, however, instantaneous mixing in any compartment); and use, in a limited manner, of time-varying coefficients. It is also pointed out that such a computer will allow the choice of different flow rates in different directions across the same boundary. The model is designed to aid in determining what parameters are measurable or even controllable. (P.C.H.)

38916 STRUCTURE ANALYSIS BY MEANS OF COLD NEUTRONS. J. A. Janik (Jagiellonian Univ., Krakow and Inst. for Nuclear Physics, Krakow). Kernenergie, 6: 368-75(Aug. 1963). (In German)

Experimental methods for structural analysis with cold neutrons are described. Scattering of cold neutrons by gases and uses of cold neutrons for structural investigations of solids and liquids are discussed. (M.C.G.)

38917 THE ACTIVATION OF MOLECULAR HYDROGEN BY DISSOLVED HOMOGENEOUS CATALYST IN AQUEOUS SOLUTION. U. Schindewolf (Technische Hochschule, Karlsruhe, Ger.). Z. Elektrochem., 67: 219-28(1963). (KFK 147). (In German)

Aqueous solutions of sodium hydroxide and of complexes of ruthenium(III) chloride and cobalt(II) cyanide catalyze the p-hydrogen conversion and the isotopic exchange between hydrogen and water. For $RuCl_3$ and NaOH, the reaction rates are proportional to the hydrogen pressure and to the Ru^{3+} or OH^- concentration, respectively. In the case of cobalt cyanide, the rate increases only slightly with the hydrogen pressure, but is proportional to the square of the concentration of Co^{2+}. The rate-determining step of the reactions with $RuCl_3$ and NaOH as catalyst is the activation of hydrogen which leads to a transition state with heterolytic bond fission of hydrogen. Cobalt cyanide splits hydrogen homolytically and the rate-determining reaction step of the isotope exchange and p-hydrogen conversion is the recombination of hydrogen atoms attached to cobalt cyanide. Hydrogen activated by cobalt cyanide and ruthenium chloride complexes reduces or hydrogenates added substrates, whereas OH^- ions effectively catalyze no hydrogen reac-

tions except the isotope exchange and p-hydrogen conversion. (auth)

Analytical Procedures

Refer also to abstracts 38640, 38641, and 39429.

38918 (DP-840) AUTOMATIC COLORIMETRIC DETERMINATION OF URANIUM AND NEPTUNIUM. Robert D. Britt, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). July 1963. Contract AT(07-2)-1. 12p.

Colorimetric methods for uranium and neptunium were adapted to an automatic colorimeter to achieve superior precision, sensitivity, and speed of analysis. At concentrations of 0.24 to 1 g U/l and of 0.01 to 3 g Np/l, the coefficient of variation was 1% or less. With the automated system, 20 samples per hour can be analyzed. (auth)

38919 (EUR-118.f) MICROANALYSE A SONDE ELECTRONIQUE D'ECHANTILLONS RADIOACTIFS. (Quantitative Electron Microprobe Analysis of Radioactive Materials). J. P. Lecoq and R. Theisen (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1962. 10p.

The analytical possibilities of an electron probe microanalysis in presence of radioactive and irradiated materials were studied. For the quantitative microanalysis of α emitters in an electron beam probe equipped with fully focalized spectrometers, a relatively simple method is proposed. The analysis of irradiated samples requires slight modifications of the commercial instruments, involving in particular the use of a proportional counter followed by a pulse-height selector, the use of a special specimen holder and judiciously placed lead screens, an orientable crystal press, and short interreticular distance analyzing crystals. (auth)

38920 (IEA-60) A METHOD FOR THE DETERMINATION OF $Sr^{90}-Y^{90}$ BY USING EDTA AND ION-EXCHANGERS-APPLICATION TO THE DETERMINATION OF THOSE RADIOISOTOPES IN MILK. Celia Machado Silva and Fausto W. Lima (Brazil. Instituto de Energia Atomica, Sao Paulo). June 1963. 16p. (CONF-115-2)

From Inter American Nuclear Energy Commission Pan American Conference on Radiochemistry, Montevideo, July 1963.

A method in which the complex of ethylenediaminetetraacetic acid (EDTA) with yttrium, used in conjunction with ion exchangers, for the determination of $Sr^{90}-Y^{90}$ is described. The method was applied to the determination of concentration of $Sr^{90}-Y^{90}$ in milk, avoiding, in this way, protein elimination by acid precipitation or by evaporation of milk and ashing the residue. Analysis of samples of milk from various places in the State of S. Paulo, Brazil, were carried out and the results are reported. Values found are much lower than maximum permissible concentration. (auth)

38921 (RFP-330) PLUTONIUM NITRATE SHIPPING INVESTIGATION. F. J. Miner and J. T. Byrne (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). [Sept. 3, 1963]. Contract [AT(29-1)-1106]. 11p. (CONF-160-2)

From Annual Atomic Energy Commission Contractors Meeting, Nuclear Materials Management, Idaho Falls, Idaho, Oct. 1963.

With the AEC complex there has been a long history of shipper-receiver assay differences in the transfer of plutonium nitrate solutions. Since the AEC is considering establishing plutonium nitrate as one of the chemical forms of plutonium for Commission purchase of privately produced plutonium, it is necessary that the shipper-receiver problem be resolved. The program formulated by Rocky Flats for doing this, and the results obtained to date, are discussed. (auth)

38922 (SCTM-369-59(51)) TEST GROUP 57 RADIOCHEMISTRY. R. J. Everett and R. W. Drake (Sandia Lab., Albuquerque, N. Mex.). Mar. 1960. Contract [AT(29-1)-789]. 23p.

Results of plutonium and uranium analyses of samples taken in the field from the Nevada Test Site during Operation Plumbbob are given. The chemistry of uranium and plutonium, methods used, procedures involved, counting statistics, and information pertinent to this aspect of the Test Group 57 effort are discussed. (auth)

38923 (EURAEC-710) THE FLUOROMETRIC DETERMINATION OF URANIUM. Special Report No. 13. (Brussels. Centre d'Etude de l'Energie Nucleaire and Societe Belge pour l'Industrie Nucleaire, Brussels). [nd]. Work Performed under United States–Euratom Joint Research and Development Program. 18p. (A translation of BN-6212-02).

A sensitive and reproducible fluorometric method for determining traces of uranium in plutonium-containing solutions is described. The latter constitute an intermediate step in the recycling of plutonium, used in a program for the study of plutonium as a nuclear reactor fuel. It contains the conditions of the sample preparation and the influence of cationic and anionic impurities on the fluorescence of uranium determined by the dilution method. It was concluded that, independently of the uranium content, plutonium, iron, and zirconium may be tolerated, respectively, up to 10^{-5}, 10^{-8}, and 10^{-6} g per sample. (auth)

38924 PERFORMANCE OF AN INSTRUMENT FOR SIMULTANEOUS GAS CHROMATOGRAPHIC AND RADIOACTIVITY ANALYSIS. D. C. Nelson, P. C. Ressler, Jr., and R. C. Hawes (Applied Physics Corp., Monrovia, Calif.). Anal. Chem., 35: 1575-9(Oct. 1963).

An instrument for simultaneous gas chromatography and radioactivity analysis is described. The ion chamber used for the radioactivity measurement is contained in the same temperature-controlled oven as the normal chromatography detector, and can be heated to over 300°C. Data are given for both programmed and isothermal column operation at high and low temperatures. Specific applications are described. Sensitivity, linearity of response, response times, and resolution are discussed for the entire system. (auth)

38925 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM WITH 4-(2-PYRIDYLAZO)RESORCINOL. T. M. Florence and Yvonne Farrar (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Anal. Chem., 35: 1613-16 (Oct. 1963).

A highly sensitive and selective method is described for the spectrophotometric determination of uranium. The chromogenic reagent is 4-(2-pyridylazo)resorcinol (PAR), and the determination is carried out at pH 8.0 in the presence of a mixed complexing solution containing (1,2-cyclohexylenedinitrilo)tetraacetic acid, sulfosalicylate, and fluoride. Most metals, including thorium, are masked by the complexing solution. Uranium forms a 1:1 complex with PAR, which has a molar absorptivity of 38,700 at 530 mμ. A preliminary separation of uranium from gross amounts of impurities may be accomplished by a rapid chelating-resin ion exchange procedure. (auth)

38926 NEUTRON FLUX MONITORING FOR ACTIVATION ANALYSIS OF OXYGEN. J. T. Gilmore and D. E.

Hull (California Research Corp., Richmond, Calif.). Anal. Chem., 35: 1623-5(Oct. 1963).

A neutron flux monitor was constructed that gives improved accuracy and speed in the activation analysis for oxygen. Oxygen in a piece of Lucite located near the neutron source and oxygen in the sample are activated simultaneously. Following irradiation, activities in the Lucite monitor and in the sample are counted simultaneously. The simultaneous irradiation and counting of monitor and sample make the analytical result independent of variations in neutron flux, durations of irradiation, sample transfer to counter, and counting periods. Monitoring accuracy is limited primarily by counting statistics, and relative standard deviations of 1% are achieved. For routine analysis, a sequence timer controls irradiation, sample transfer, and counting in a 45-second cycle, leaving only sample weighing and calculation for the complete analysis. (auth)

38927 A SPECTROPHOTOMETRIC STUDY OF THE COMPLEXES FORMED BETWEEN URANYL AND THIOSULFATE IONS IN WATER AND WATER–ETHANOL SOLVENTS. Sharon Lynn Melton and Edward S. Amis (Univ. of Arkansas, Fayetteville). Anal. Chem., 35: 1626-30(Oct. 1963).

Using the method of continuous variations at 25°C, the complex $UO_2S_2O_3$ was proved to exist in dilute aqueous solutions and in dilute solutions in 30-, 60-, and 90-vol % ethanol. The complex $(UO_2)_3(S_2O_3)_2^{2+}$ was found by the same method in more concentrated aqueous solutions. The equilibrium constants for the dissociation of $UO_2S_2O_3$ in the various solvents were determined at 25°C and the free energy of the process was calculated. In water and 60 vol % ethanol the equilibrium constant for the dissociation of the complex was determined at three or more temperatures and the thermodynamic functions $\Delta F°$, $\Delta H°$, and $\Delta S°$ were calculated. The limit of identification and the limit of dilution for the detection of uranyl ion by a thiosulfate spot test were investigated, and some of the ions that interfere with the test are listed. (auth)

38928 DETERMINATION OF PLUTONIUM IN BIOLOGICAL MATERIAL BY SOLVENT EXTRACTION WITH PRIMARY AMINES. F. W. Bruenger, B. J. Stover, and D. R. Atherton (Univ. of Utah Coll. of Medicine, Salt Lake City). Anal. Chem., 35: 1671-3(Oct. 1963).

An accurate and simple procedure for the determination of plutonium in biological materials was developed. Concentrated urine, or a solution of bone ash, is made at least 1M in H_2SO_4, and plutonium is extracted with a mixture of C_{18} to C_{23} highly branched primary amines in xylene. Plutonium is then extracted from the organic phase with 8M HCl, and measured by alpha counting. (auth)

38929 AMPEROMETRIC TITRATION OF PLUTONIUM(VI) WITH IRON(II). C. A. Seils, Jr., R. J. Meyer, and R. P. Larsen (Argonne National Lab., Ill.). Anal. Chem., 35: 1673-5(Oct. 1963). (TID-18832)

A method was developed for the precise titration of plutonium(VI) with iron(II) in which the end point is detected amperometrically with a rotating platinum electrode. The plutonium is oxidized to the sexivalent state in a sulfuric acid medium with argentic oxide, the excess oxidant destroyed by heating, and the plutonium titrated by the addition of standard iron(II) sulfate from special weight burets. For 15-mg samples, precisions of ±0.06% relative standard deviation are obtainable with no significant bias. For 0.2-mg samples, the relative standard deviation is 0.4% with a 0.6% negative bias. (auth)

38930 AUTOMATIC, AMPEROMETRIC, CUPFERRON TITRATION OF ZIRCONIUM IN HIGHLY RADIOACTIVE SOLUTIONS. Hisashi Kubota and J. G. Surak (Oak Ridge National Lab., Tenn.). Anal. Chem., 35: 1715-18(Oct. 1963).

A previously reported amperometric titration of zirconium and cupferron was modified and adapted for hot cell analysis. A titration was devised in which the current is monitored continuously while the titrant is fed in at a constant rate. A stirred mercury pool is the indicating electrode that senses the point where cupferron comes into excess, and a platinum wire is used for the reference. Precision of 1% relative standard deviation is obtainable for benchtop analysis and 1.5% for titrations in a hot cell. The titration was specifically devised for the analysis of zirconium in molten salt reactor fuel, and the titration can be performed directly following dissolution without the need for separations. (auth)

38931 SIMPLIFIED METHOD FOR DETERMINING SENSITIVITIES IN ACTIVATION ANALYSIS. B. T. Kenna (Sandia Corp., Albuquerque, N. Mex.) and L. A. Kenna (Army Electronic Proving Ground, Ft. Hauchuca, Ariz.). Anal. Chem., 35: 1766-8(Oct. 1963). (TID-17989; SCDC-3035)

A method is described for determining sensitivities in activation analysis without assuming specific fluxes and irradiation periods. Since counting efficiencies and time intervals are absent in the procedure, the method is cumbersome in that calculations are necessary to obtain quantitative results. However, this is compensated for by the fact that, after a little experience excellent qualitative estimations without written calculations can be made. (P.C.H.)

38932 SUBSTOICHIOMETRIC DETERMINATION OF TRACES OF MOLYBDENUM BY NEUTRON ACTIVATION ANALYSIS. Jiří Starý, Jaromir Růžička, and Adolf Zeman (Faculty of Technical and Nuclear Physics, Prague). Anal. Chim. Acta, 29: 103-6(Aug. 1963). (In English)

A rapid, simple activation method for the selective determination of traces of molybdenum is proposed. With substoichiometric reagent addition, the required element need not be isolated in a weighable form and the chemical yield need not be determined. Molybdenum is simultaneously separated not only from metal impurities but also from the bulk of matrices such as germanium. (auth)

38933 GRAVIMETRIC SEPARATION OF TITANIUM AND ZIRCONIUM FROM NIOBIUM WITH PHENYLACETYLHYDROXAMIC ACID. A. K. Majumdar and Bijoli K. Pal (Jadavpur Univ., Calcutta). Anal. Chim. Acta, 29: 168-71(Aug. 1963). (In English)

Phenylacetylhydroxamic acid is used to separate titanium and zirconium from niobium in an oxalate medium at pH 6.5–7.5 in presence of ammonium chloride at room temperature. The method is accurate when the ratio of $(TiO_2 + ZrO_2) : Nb_2O_5$ is 10 : 1 to 1 : 1; when the niobium concentration is higher, reprecipitation is necessary. Tantalum, citrate, tartrate, lactic acid, EDTA, and a large excess of oxalate interfere. (auth)

38934 THE DETERMINATION OF STRONTIUM IN COAL ASH BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. C. B. Belcher and K. A. Brooks (Broken Hill Proprietary Co. Ltd., Shortland, N.S.W., Australia). Anal. Chim. Acta, 29: 202-5(Sept. 1963). (In English)

An atomic absorption spectrophotometric method for the determination of 0.01–0.40% strontium in coal ashes is proposed. After suitable dissolution of the sample, 2000 ppm of lanthanum are added to overcome interferences before the solution is atomized. The results obtained were compared with those obtained by flame-emission spectro-

photometry. The method is rapid and no preliminary separations are necessary. (auth)

38935 RAPID ACTIVATION ANALYSIS OF TRACE VANADIUM IN TISSUE USING 3.8-MINUTE VANADIUM-52. David G. Kaiser and W. Wayne Meinke (Univ. of Michigan, Ann Arbor). Anal. Chim. Acta, 29: 211-14(Sept. 1963). (TID-16806). (In English)

Submicrogram amounts of vanadium in rat liver tissue were analyzed by rapid activation analysis. A 5-min radiochemical separation coupled with γ-ray spectrometry permitted utilization of the 3.8-min V^{52} radioisotope. With this procedure the lower limit of detection at a thermal neutron flux of 10^{12} n/cm²/sec was about $3 \cdot 10^{-9}$ g of vanadium. (auth)

38936 STRUCTURE OF THE ZIRCONIUM-ALIZARIN S COMPLEX IN RELATION TO pH CHANGES. G. Parissakis and J. Kontoyannakos (National Technical Univ., Athens). Anal. Chim. Acta, 29: 220-6(Sept. 1963). (In English)

A comparison of the absorption spectra of the zirconium-alizarin S complex with those of alizarin S at different pH values shows that the action of hydrogen ions and zirconium(IV) on alizarin S is similar. Changes caused by pH alterations are discussed. Between pH 1 and 1.8 the zirconium-alizarin S complex has the molar ratio 1:1; at higher pH, suspensions of hydroxy complexes of zirconium are formed, which adsorb the above complex. (auth)

38937 DETERMINATION OF URANIUM(VI) BY TRI-n-OCTYLPHOSPHINE OXIDE EXTRACTION AND COULOMETRIC TITRATION. W. D. Shults and Louise B. Dunlap (Oak Ridge National Lab., Tenn.). Anal. Chim. Acta, 29: 254-60(Sept. 1963). (In English)

Optimum conditions were established for the extraction, back-extraction, and overall performance. The method is accurate, precise, and widely applicable. (P.C.H.)

38938 REMOVAL OF INTERFERENCES IN ABSORPTIOMETRIC DETERMINATION OF BISMUTH WITH THORIN. Horacia A. Mottola (Universidad, Buenos Aires). Anal. Chim. Acta, 29: 261-6(Sept. 1963). (In English)

Bismuth was separated by ion-exchange adsorption on Dowex 21 K resin from ca 0.25 M HCl, after removal of volatile interferences by distillation in acid-oxidizing medium. Bismuth is eluted from the column with 1 M sulfuric acid. The method is useful in the absorptiometric determination of bismuth with thorin, as well as in other photometric methods. (auth)

38939 POLAROGRAPHIC DETERMINATION OF MOLYBDENUM IN URANIUM–MOLYBDENUM ALLOYS. V. T. Athavale, R. Kalyanaraman, and K. A. Khasgiwale (Atomic Energy Establishment, Trombay, India). Anal. Chim. Acta, 29: 280-2(Sept. 1963). (In English)

A polarographic method is described for the determination of Mo in the range of 0.01 to 1.0% in U–Mo alloys. A binary alloy of U and Mo when analyzed by the proposed method gave a Mo result of 0.033%. The accuracy of the determination is ±3%. (P.C.H.)

38940 GRAVIMETRIC DETERMINATION AND SEPARATION OF TITANIUM WITH N-BENZOYL-N-PHENYLHYDROXYLAMINE BY DIRECT WEIGHING. V. R. M. Kaimal and S. C. Shome (Presidency Coll., Calcutta). Anal. Chim. Acta, 29: 286-8(Sept. 1963). (In English)

It is shown that Ti can be determined by direct weighing of the Ti-benzoylphenylhydroxylamine complex formed in hot (65–75°C) acidic solution, the composition of the complex being $TiO(C_{13}H_{10}O_2N)_2$. The method can also be applied to the separation of Ti from many elements after addition of masking agents or pH adjustment. Ti was determined in the presence of Fe, V, Zr, or Cu by complexing the foreign ions with magnesium-EDTA complex. Ti was also separated from U, Ce, Th, Al, Cr, Co, Ni, Zn, and Mn, since they do not form precipitates with benzoylphenylhydroxylamine below pH 2. (P.C.H.)

38941 THE DETERMINATION OF SELENIUM IN BIOLOGICAL MATERIAL BY RADIOACTIVATION. H. J. M. Bowen and P. A. Cawse (United Kingdom Atomic Energy Authority, Wantage Berks, Eng.). Analyst, 88: 721-6(Sept. 1963).

Neutron-activation analysis was applied to the determination of selenium in biological material. Samples were activated in a flux of 10^{12} neutrons per cm² per second for 18 minutes, and a rapid chemical separation was developed for Se^{81}. Under these conditions the practical limit of sensitivity was found to be 5×10^{-9} g. Decontamination from arsenic, bromine, manganese, sodium, and zinc was tested and found to be satisfactory. Selenium contents of fertilizers, tomato tissue, and human blood were measured by the procedure. (auth)

38942 DETERMINATION OF THORIUM AND PHOSPHORUS PENTOXIDE IN SOLUTION AND IN INSOLUBLE THORIUM PHOSPHATE. Abdur Rahman (Imperial Coll. of Science and Tech., London). Analyst, 88: 727-31(Sept. 1963).

Methods are described for the gravimetric determination of thorium in the presence of substantial amounts of phosphate, and of phosphate in the presence of thorium. The application of these methods to the analysis of insoluble thorium phosphates is described. (auth)

38943 ANALYTICAL CHEMISTRY OF COBALT. C. Tombu (Société Générale Métallurgique, Hoboken, Belg.). Cobalt, No. 20, 103-10(Sept. 1963). (In English)

The advantages and drawbacks in methods used in analyzing Co are described. The detection and determination of Co traces in soils, plants, fertilizers (in which Co is a useful constituent), or in certain materials in which Co is an undesirable impurity (such as special steels) and the determination of high Co contents in ores and alloys are discussed. (P.C.H.)

38944 SPECTROPHOTOMETRIC INVESTIGATION OF THE REACTIONS OF BISMUTH, THORIUM, ZIRCONIUM, VANADIUM, TITANIUM, AND SCANDIUM WITH XYLENOL ORANGE AND DETERMINATION OF TRACE AMOUNTS OF THESE METALS IN URANIUM. B. Buděšínský (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Řež). Collection Czech. Chem. Commun., 28: 1858-66 (July 1963). (In German)

The optimum conditions for the reactions of Xylenol Orange with Bi^{3+}, Th^{4+}, Zr^{4+}, V^{5+}, Ti^{4+}, and Sc^{3+} were found, the composition of the complexes formed was determined, and the values of the corresponding formation and stability constants were calculated. The theoretical and practical possibilities for the determination of trace amounts of these metals in U were indicated. (tr-auth)

38945 NEUTRON ACTIVATION ANALYSIS OF POLYPHENYLS. L. Ciuffolotti, G. B. Fasolo, and R. Malvano (SORIN, Centro Ricerche Nucleari, Saluggia, Italy). Energia Nucl. (Milan), 10: 381-8(July 1963). (In English)

Neutron activation analysis was applied to the determination of some impurities in commercial-grade polyphenyls. The use of both direct and destructive techniques allowed an evaluation of as many as sixteen trace elements (Al, Au, Cl, Co, Cr, Cu, Fe, Mn, Mo, Na, Ni, P, S, Sb, Sc, and Zn) in concentrations ranging from 200 ppm to 10^{-4}

ppm. The analytical procedure is described, and the results and the precision of the method are discussed. (auth)

38946 DETERMINATION OF SULPHUR IN ORGANIC MATERIALS BY NEUTRON ACTIVATION TECHNIQUES. B. Chinaglia, L. Ciuffolotti, and R. Malvano (SORIN, Centro Ricerche Nucleari, Saluggia, Italy). Energia Nucl. (Milan), 10: 389-94(July 1963). (In English)

The methods of activation analysis of sulfur by direct measurement of produced P^{32} or S^{37} activity are discussed and the interferences from phosphorus and chlorine evaluated. Some examples of sulfur determination in polyphenyls (P^{32} method) and in crude oils (S^{37} method) are also reported. (auth)

38947 RADIOACTIVATION ANALYSIS OF OXYGEN IN HIGH-PURITY SILICON BY IRRADIATION WITH α-PARTICLES. K. Saito, T. Nozaki, S. Tanaka, M. Furukawa, and Hwasheng Cheng (Tokyo Univ.). Intern. J. Appl. Radiation Isotopes, 14: 357-63(Aug. 1963). (In English)

The apparent σ-value for the combined reactions $O^{16}(\alpha,pn)F^{18}$ and $O^{16}(\alpha,d)F^{18}$ is fairly high (ca 200 mbarn at 35 Mev) and the use of α-particles of up to 40 Mev is very advantageous. The average recoil range of the F^{18} atoms is about 0.9 mg/cm^2 in silicon in the energy range 25–38 Mev. When a thin surface layer (about 5 mg/cm^2) of irradiated silicon is removed mechanically by manual grinding, the amount of F^{18} in the remaining piece, measured with the aid of chemical separation, indicates the oxygen content in the bulk of the silicon. Carbon-11 formed by the reaction $C^{12}(\alpha,\alpha n)C^{11}$ gives a similar recoil effect and the bulk carbon content can also be estimated. The method is also useful for the analysis of other high-melting point metals. (auth)

38948 MEASUREMENT OF INTENSITY OF X-RADIATIONS OF NEIGHBOURING ENERGIES BY NON-DISPERSIVE SPECTROMETRY. APPLICATION TO THE ANALYSIS OF SILICA, ALUMINA, MAGNESIA MIXTURES. J. Y. Le Traon, and G. Seibel (Institut de Recherches de la Sidérurgie, Saint Germain ien Laye, France). Intern. J. Appl. Radiation Isotopes, 14: 365-79(Aug. 1963).

Studies were made on the possibilities of extending analysis by non-dispersive spectrometry of x rays excited by fluorescence using a radioactive source, to three cases currently encountered in practice: measurement of the characteristic x radiations of the light elements, by operating under vacuum with a proportional flow counter; measurement of x radiation whose peak is superimposed on the escape peak of a higher energy radiation; and measurement of characteristic x radiations of elements of neighboring atomic numbers. Thus the application of non-dispersive spectrometry to the simultaneous analysis of Fe, Mn, Ca, Si, Al, and Mg in iron ores can be envisaged. (auth)

38949 A METHOD FOR THE RAPID DETERMINATION OF BETA-AMINO-ISO-BUTYRIC ACID (BAIBA) IN URINE OF IRRADIATED HUMANS. F. W. Meichen and A. W. Short (United Kingdom Atomic Energy Authority, Preston, Lancs, Eng.). Intern. J. Radiation Biol., 6: 495-7(May 1963). (In English)

A method is described for the rapid determination of β-aminoisobutyric acid (BAIBA) in urine. The method uses a combination of absorption-column and paper chromatographic techniques. It is suggested that the determination of BAIBA in urine may be used as a conjunct to other methods of assessing radiation exposure in humans. (C.H.)

38950 MODIFICATIONS IN THE SIMULTANEOUS DETERMINATION OF CARBON, HYDROGEN, AND NITROGEN. Jack W. Frazer and Richard Crawford (Univ. of California, Livermore). Mikrochim. Acta, No. 3, 561-6 (1963). (UCRL-7328-T). (In English)

Improved analytical procedures are presented for the simultaneous determination of C, H, and N in solid organic materials by the gas volumetric method. By the removal of halogens and SO_2 from the combustion products and the complete reduction of NO and some minor modifications to take care of second-order corrections, the accuracy is improved, and the method is less dependent upon the analyst's technique. (P.C.H.)

38951 DETERMINATION OF SILICON IN ZIRCONIUM SALTS BY THE SILICOMOLYBDIC BLUE METHOD. Helena Skiba. Prace Inst. Hutniczych, 14: 323-5(1962). (In Polish)

The determination of silicon in zirconium nitrate, sulfate, and chloride and in potassium fluorozirconate is described. Silicic acid is converted into the colorimetrically active form by heating the solution with an addition of 0.5 n sodium hydroxide. Precipitation of zirconium ions in these conditions is prevented by an addition of solution of ammonium carbonate. Silicomolybdic acid formed at pH = 1 is reduced with ascorbic acid in 0.8 n sulfuric acid. Interference due to phosphorus and arsenic is eliminated by an addition of 10% solution of citric or tartaric acid to the mixture of heteropolyacids, whereby only phosphoro and arsenomolybdic acids are decomposed. (auth)

38952 AN ANALYTICAL PROCEDURE FOR IDENTIFICATION OF FISSION PRODUCTS IN RAIN WATER. K. Buchtela and Margrit Lesigang (Universität, Vienna). Radiochim. Acta, 1: 208-12(Aug. 1963). (In German)

An analytic procedure is described for the detection of several important fission products (Ru^{106}/Rh^{106}, Mo^{99}, Ce^{144}, Zr^{95}/Nb^{95}, Ba^{140}/La^{140}, Sr^{90}, and I^{131}). It can be used for samples containing higher amounts of inactive material. It is suitable for the study of residues obtained by the evaporation of natural waters (rain water), which contain much iron and calcium. The procedures are simple and fast; the separations are by precipitation (by isotopic and non-isotopic carriers) and extraction. (auth)

38953 COMMENTS ON NEUTRON SOIL MOISTURE PROBE EFFICIENCY AND SENSITIVITY. Robert A. Merriam and Otis L. Copeland (Dept. of Agriculture, Ogden, Utah). Soil Sci. Soc. Am. Proc., 27: 106-7(Jan.-Feb. 1963).

The ability of neutron probes to provide accurate and reproducible soil moisture measurements is discussed. It is stressed that sensitivity of the probe in terms of soil moisture measurements is of greater interest than efficiency in terms of absolute counts or counting rate per millicurie. The importance of calibration curve slope rather than absolute count per minute at a particular soil moisture content is illustrated. (P.C.H.)

38954 DETERMINATION OF ADSORBED STRONTIUM BY X-RAY EMISSION IN CATION-EXCHANGE CAPACITY DETERMINATIONS OF CLAYS. S. B. Weed and R. A. Leonard (North Carolina State Coll., Raleigh). Soil Sci. Soc. Am. Proc., 27: 474-5(July-Aug. 1963).

Fusion of Sr^{2+}-saturated clay with $K_2S_2O_7$ resulted in a sample that lent itself to the accurate determination of Sr^{2+} by x-ray emission spectrometry. Matrix effects occasioned by variable clay composition were negligible. The method gave CEC values in close agreement with those obtained by Ca^{2+}-saturation. Details of the method are given. (P.C.H.)

38955 THE INFRARED SPECTRA OF CHELATE COMPOUNDS. III. A STUDY OF SOME TERVALENT

METAL CHELATE COMPOUNDS OF 8-HYDROXYQUINOLINE IN THE REGION 5000-250 cm^{-1}. R. J. Magee and Louis Gordon (Case Inst. of Tech., Cleveland). Talanta, 10: 967-70(Sept. 1963). (In English)

The infrared spectra of 8-hydroxyquinoline and of its complexes with aluminum, gallium, and indium were determined in the region 5000–250 cm^{-1}. The spectra show similarities, but differences between the aluminum complex and the other two occur in the region 625–250 cm^{-1}. A discussion of the spectra and of the structures of the oxinates is presented. (auth)

38956 A NEW PRINCIPLE OF ACTIVATION-ANALYSIS SEPARATIONS. V. SUBSTOICHIOMETRIC DETERMINATION OF TRACES OF INDIUM. Adolf Zeman, Jiří Starý, and Jaromír Růžička (Faculty of Technical and Nuclear Physics, Prague). Talanta, 10: 981-5(Sept. 1963). (In English)

A substoichiometric determination of traces of indium in germanium dioxide was developed. It consists of adding indium carrier to the dissolved irradiated sample followed by extraction of indium dithizonate using thiosulphate and cyanide as masking agents. Indium is removed from the organic extract by shaking with dilute sulfuric acid. To the separated aqueous layer a substoichiometric amount of EDTA is added and the indium complex separated from the excess of unreacted indium ions on a cation-exchange column. The content of indium is calculated from the activity of the eluate obtained. The method is very selective, simple, and rapid. Using the substoichiometric separation principle the necessity of determining the chemical yield is avoided. (auth)

38957 THE DETERMINATION OF TRACES OF COBALT IN SAMPLES OF PLATINUM BY NEUTRON-ACTIVATION ANALYSIS. D. F. C. Morris and R. A. Killick (Brunel Coll., London). Talanta, 10: 987-90 (Sept. 1963). (In English)

A neutron-activation analysis method for the determination of traces of cobalt in samples of purified platinum is described. Using a pile flux of 1.2×10^{12} thermal neutrons cm^{-2} sec^{-1}, as little as 10^{-9} g of cobalt may be determined. A rapid radiochemical separation procedure coupled with gamma-ray spectrometry permits measurement of 5.26-year Co^{60} activity. Results of analysis of seven samples of platinum are quoted. (auth)

38958 THE EFFECT OF ISOTOPE ABUNDANCES ON THE NEUTRON-ABSORPTIOMETRY TECHNIQUE. R. S. Braman (Callery Chemical Co., Penna.). Talanta, 10: 991-6(Sept. 1963). (In English)

To obtain accurate analyses by neutron absorptiometry it is essential that the isotope abundance of the element determined be the same as that of the calibration standard. The effect was used for the comparison and determination of B^{10} isotope abundances in various boron hydrides. Precision is in the ±0.1% relative range. (auth)

38959 DETERMINATION OF NICKEL IN HIGH-PURITY NIOBIUM, TANTALUM, MOLYBDENUM AND TUNGSTEN METALS BY CHLOROFORM EXTRACTION OF NICKEL^{II} DIMETHYLGLYOXIMATE. Elsie M. Penner and W. R. Inman (Dept. of Mines and Technical Surveys, Ottawa). Talanta, 10: 997-1003(Sept. 1963).

A spectrophotometric method for determining 0.0005–0.10% of nickel in high-purity niobium, tantalum, molybdenum, and tungsten metals is described. After sample dissolution and pH adjustment to 6.0, nickel(II) dimethylglyoximate is extracted with cholorform from an ammonium tartrate-boric acid medium. The chloroform extract is washed with dilute ammonia solution to remove interfering impurities, and nickel is determined spectrophotometrically at 370 mμ directly in the extract. (auth)

38960 ABSORPTIOMETRIC DETERMINATION OF NIOBIUM^{V} WITH 4-(2)PYRIDYLAZO)-RESORCINOL AS REAGENT. R. Belcher, T. V. Ramakrishna, and T. S. West (Univ. of Birmingham, Eng.). Talanta, 10: 1013-22 (Sept. 1963). (In English)

4-(2-Pyridylazo)-resorcinol forms a 1:1 purple-colored complex (λ_{max} = 550 mμ) with niobium(V) in an acetate-tartrate medium as pH 5.8. This is suitable for the spectrophotometric determination of niobium down to 0.1 ppm. The color is formed within 45 min, and is stable thereafter for several days; the molecular extinction coefficient, $\epsilon_{550m\mu}$ = 38,700, is as high as that reported for the well-known thiocyanate procedure, and the stability is very much superior. The interference of over 40 ions was examined at the 1000-μg level in the presence of excess of cyanide and EDTA; only uranium(VI), vanadium(V), and phosphate interfere. Vanadium may be masked by addition of zinc ions and uranium by ammonium oxalate. 1000 μg of tantalum exhibit weak color formation with the reagent, but this can be eliminated by the addition of larger amounts of tartrate, with only a slight decrease in the sensitivity of the niobium reaction. The new procedure does not necessitate an extraction, and is easier to operate than the standard methods. (auth)

38961 A NEW REDUCTIMETRIC REAGENT: IRON^{II} IN A STRONG PHOSPHORIC ACID MEDIUM. IV. SIMULTANEOUS POTENTIOMETRIC DETERMINATION OF VANADIUM^{V} AND URANIUM^{VI} (OR MOLYBDENUM^{VI}) IN MIXTURES. G. Gopala Rao and L. S. A. Dikshitulu (Andhra Univ., Waltair, India). Talanta, 10: 1023-9(Sept. 1963). (In English)

The formal redox potential of the V(V)/V(IV) couple was determined in a medium of varying phosphoric acid concentration. Potentiometric procedures were developed for the simultaneous titrimetric determination of vanadium(V) and uranium(VI) (or molybdenum(VI)) in mixtures, using iron(II) as a reductimetric reagent in 12M phosphoric acid. Two breaks in potential are obtained, the first corresponding to the complete reduction of vanadium(V) to vanadium(IV), and the second to the simultaneous reduction of vanadium(IV) to vanadium(III) and uranium(VI) to uranium(IV) (or molybdenum(VI) to molybdenum(V)). Manganese(II) and tungsten(VI) do not interfere. The procedures have definite advantages over those involving titanium(III), tin(II), and chromium(II). (auth)

38962 THE DETERMINATION BY X-RAY FLUORESCENCE OF MICROGRAM AMOUNTS OF STRONTIUM IN WATER AND IN MILK. Asko Visapaeae. Valtion Tek. Tutkimuslaitos, Tiedotus, Sarja IV, No. 53, 3-8(1963). (In English)

A new method, based on x-ray fluorescence, is presented for the determination of microgram amounts of Sr in water and in milk. A quantity as small as 1 μg of Sr per ml is determinable in both liquids. The time needed for one determination is about 2 min. (auth)

38963 THE POSSIBILITY OF USING ELECTRON ACCELERATORS FOR THE PHOTONEUTRON DETERMINATION OF BERYLLIUM. E. V. Egorov. Vopr. Rud. Geofiz., Min. Geol. i Okhrany Nedr SSSR, No. 3, 147-59 (1961).

A theoretical evaluation is presented on the possibility of using an electron accelerator for the photoneutron determination of Be^{9} in ores. It is demonstrated that the

neutron yield is a linear function of the Be^9 concentration in the sample and the current strength at the target of the accelerator. An accelerator for ~2.7 Mev with a mean current in the beam of ~280 μa (230 ma per pulse) with a tungsten target makes it possible to obtain up to 800 neutrons/min at a $\sim 2.10^{+3}$% concentration of BeO in the sample. A concentration of Be^9 in samples of up to 10^{-5}% can therefore be measured with this installation to an accuracy equally as good as that of existing installations with radioactive sources. By using electron accelerators, the efficiency of photoneutron determinations of Be^9 can be increased by a factor of 20-40, the measuring error can be reduced from 50 to 3-5% at BeO concentrations of $\sim 10^{-5}$% in the sample, and the safety of the attendant personnel can be reliably ensured. (OTS)

38964 ANALYSIS OF PURE SILICON CARBIDE BY NEUTRON ACTIVATION. E. A. Isaeva, I. E. Makasheva, and A. P. Obukhov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Analit. Khim., 18: 979-83(Aug. 1963). (In Russian)

A method is described for neutron activation analysis of silicon carbide for Zn, Cu, As, Sb, and P after the decomposition of the sample by chlorination at 1250 to 1300°C. The activity of the reference sources and of the impurities isolated from the samples is measured by means of a multichannel γ-spectrometer. The sensitivity of the determinations is within 10^{-6} to 10^{-7}%. (auth)

38965 GRAVIMETRIC DETERMINATION OF THORIUM WITH DIHYDROXYMALEIC ACID. N. D. Sadzhaya (Tbilisi State Pedagogical Inst., USSR). Zh. Analit. Khim., 18: 1028-9(Aug. 1963). (In Russian)

Dihydroxymaleic acid quantitatively precipitates thorium. The experimental error of thorium determination as ThO_2 is not higher than 0.03%. The method permits the determination of 10 μg of thorium in 100 ml of solution. The solubility product of thorium compounds with dihydroxymaleic acid is 2.99×10^{-13}. (auth)

38966 ANALYTICAL CHEMISTRY OF NUCLEAR MATERIALS. Report of the Panel, held in Vienna, 17-21 September 1962. (International Atomic Energy Agency, Vienna). Technical Reports Series No. 18. Aug. 1963. 85p. (STI/DOC/10/18). $2.00; Sch 42; 12s.stg; F.fr.8,-; DM 6,40(IAEA).

Three articles on analysis of U and Th, trace impurity analysis in nuclear materials, and analytical chemistry of irradiated nuclear fuel processing are included. Each article is abstracted separately in NSA. (P.C.H.)

38967 ANALYSIS OF URANIUM AND THORIUM. p.9-31 of "Analytical Chemistry of Nuclear Materials." Vienna, International Atomic Energy Agency, 1963.

A review is presented on methods used for the analysis of concentrates, alloys, ceramics, and compounds for U and Th. It was concluded that there is room for improvement in the determination of Th in material. The agreement between laboratories with thorium concentrates is not as satisfactory as those obtained with uranium concentrates. (P.C.H.)

38968 TRACE IMPURITY ANALYSIS IN NUCLEAR MATERIALS. p.33-59 of "Analytical Chemistry of Nuclear Materials." Vienna, International Atomic Energy Agency, 1963.

A review is presented on methods and problems in the determination of trace impurities in nuclear materials. 48 references are included. (P.C.H.)

38969 ANALYTICAL CHEMISTRY OF IRRADIATED NUCLEAR FUEL PROCESSING. p.61-77 of "Analytical Chemistry of Nuclear Materials." Vienna, International Atomic Energy Agency, 1963.

A critical review was made of the analytical methods and techniques necessary and available to permit operational control of irradiated nuclear fuel processing plants. The most necessary and profitable lines of future analytical methods and technique development in support of fuel processing facilities are indicated. Methods for the determination of Pu and U are discussed. 57 references are included. (P.C.H.)

38970 ADVANCES IN MASS SPECTROMETRY. Volume 2. Proceedings of a Conference held in Oxford, September 1961. R. M. Elliott, ed. Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 1-628(1963).

Forty-four papers presented at the Conference on Advances in Mass Spectrometry are given. Topics covered include: mass spectrometry in research, mass spectrometry of inorganic compounds, new instruments and techniques, mass spectrometry of organic compounds, and ionization and dissociation. A bibliography covering the period Jan. 1958 to Dec. 1960 is included. Separate abstracts were prepared for 23 papers. Two papers were previously abstracted for NSA. (M.C.G.)

38971 MASS SPECTROMETRIC STUDIES OF SOLID SURFACES. R. E. Honig (RCA Labs., Princeton, N. J.). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 25-37(1963).

A mass spectrometer was used to identify the secondary particles emitted from solid surfaces during bombardment with rare gas ions of moderate energy. The targets studied included semiconductors and insulators, such as ethyl-covered germanium, coal, silicon carbide, graphite, and diamond. Elements with low ionization potentials produced mainly positively charged atoms and molecules, elements with high electron affinities yielded mostly negative ions. Adsorbed gases and radicals were mainly desorbed as neutral particles, while neutrals characteristic of the matrix were hard to detect. The complex negative ion patterns obtained from carbon-containing surfaces are discussed. (auth)

38972 MASS SPECTRA OF ACETYLENE UNDER HIGH PRESSURE IN THE ION SOURCE. A. Bloch (Commissariat a l'Energie Atomique, Saclay, France). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 48-50(1963).

The mass spectra of acetylene was studied over a wide pressure range in an ionization chamber with a 90° sector magnetic deflection mass spectrometer modified in order to allow high pressures in the ion source. (M.C.G.)

38973 APPLICATION OF THE ISOTOPE DILUTION TECHNIQUE TO THE MEASUREMENT OF SOME NUCLEAR REACTION CROSS-SECTIONS. R. Bernas, R. George, E. Gradsztajn, and Nguyen-Long-Den (Universitδ, Paris). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 93-8(1963).

The cross section for the production of Li^8 in O^{16} and N^{14} bombardment by 155-Mev protons was measured. Values of 12 ± 4 and 8.5 ± 3 mb at Li^6/Li^7 ratios of 1/7 were obtained for the O^{16} and N^{14} cross sections respectively. The quantity of lithium produced was determined by isotope dilution using as tracer the natural lithium remaining in tridistilled water (for O^{16}) and tridistilled liquid ammonia (for N^{14}). The Na^{22}/Na^{24} ratio in aluminum bombarded by 155-Mev protons was found to be 1.8 ± 0.15. The sodium produced in the aluminum was extracted by vacuum distillation and the mass spectra were determined. (M.C.G.)

38974 MASS SPECTROMETRIC STUDIES OF HIGH TEMPERATURE SYSTEMS. W. A. Chupka, J. Berkowitz,

D. J. Meschi, and H. A. Tasman (Argonne National Lab., Ill.). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 99-109(1963). (TID-13734; UAC-5414)

The mass spectrometric technique developed for the study of vaporization processes was extended to the study of reactions of gases with condensed material at high temperatures. The reaction of hydrogen with graphite was studied with the purpose of determining the heat of formation of CH_2, the methylene free radical. The free radicals C_2H, CH, CH_2, and CH_3 were all observed in very low concentration and in apparent equilibrium with hydrogen and graphite at about 2400°K. Pyrolysis of various hydrocarbons in the same cell produced the same radicals but at widely different concentrations. The data lead to a value at 78.4 ± 6.0 kcal/mole for the heat of formation of CH_2 at 0°K. The mass spectrometer was also employed in the study of the processes of vaporization, condensation, and apparent reflection of atoms from surfaces. Metal atoms exhibit very little apparent reflection (generally less than 1%) from clean surfaces of the same metal, but carbon atoms and molecules show much apparent reflection from a graphite surface. (auth)

38975 THE THERMAL IONIZATION OF ELEMENTS OF HIGH IONIZATION POTENTIAL. E. A. C. Crouch (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 157-62(1963).

For the mass analysis of fission products and fissile isotopes it is necessary to work with samples of 10 μg or less. Although this is easy with elements of low ionization potential, special methods have to be used with the others. An examination of the ion beams during application of the "borax-bead" technique suggested that chemical complexing in conjunction with in situ formation of a surface of high work-function would lead to an efficient ionization process. A method which gives large ion beams with ~1 μg of elements such as cadmium, silver, and zinc is described and its limitations stated. (auth)

38976 ANALYSIS OF IMPURITIES IN URANIUM HEXAFLUORIDE BY MASS SPECTROMETRY. R. Boyer and R. Bir (Commissariat a l'Energie Atomique, Saclay, France). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 174-9(1963).

A mass spectrometer was developed for continuous automatic analysis of gaseous impurities contained in uranium hexafluoride. To offset the various difficulties involved in introducing UF_6 into the ion source, the uranium hexafluoride is held back in a mercury trap; the impurities alone are admitted into the ion source. A variable leak controlled by a high sensitivity Pirani gauge maintains a constant flow in the gas inlet line. The spectrometer is calibrated with gas of known composition. Mass scanning is provided according to a pre-selected program as provided by a 10-point potentiometer-recorder. One mass is recorded every 24 seconds, the sensitivity being a few parts per million. (auth)

38977 A LARGE DOUBLE FOCUSING MASS SPECTROGRAPH WITH SECOND ORDER DIRECTION FOCUSING. H. Hintenberger, J. Mattauch, H. Wende, H. Voshage, and W. Mueller-Warmuth (Max Planck-Institut fur Chemie, Mainz). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 180-8(1963).

The design of a large mass spectrograph is described. The mass spectrum is detected not only on a photographic plate, but also by electrical means using either a simple collector or a multiplier. The instrument has first-order double focusing for all masses along a plane photographic plate, and second-order direction focusing at the center of the plate. With a mixture of propane, coal gas, and air in the inlet system, a series of mass spectra with multiplets at various mass numbers were taken. The resolution was 25,000 to 27,000 for different multiplets, compared with a theoretical resolution of 27,000, at a slit width of 0.1 mm. (M.C.G.)

38978 A MASS SPECTROGRAPH FOR PARTICLES OF HIGH KINETIC ENERGY. H. Ewald, E. Konecny, and H. Opower (Technische Hochschule, Munich). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 189-97 (1963).

A large mass spectrograph for the analysis of particles of high kinetic energy is described. The apparatus will be tested initially using α particles as swift ions, and will be installed in the reactor station at Garching near Munich for the analysis of fission products coming out of thin sheets of fissionable material, arranged in an evacuated tube in the high neutron flux in the neighborhood of the core of the reactor. Those fission products travelling approximately in the direction of the tube are to be sent through the electric field of the toroidal condenser and the homogeneous magnetic field of the high resolution mass spectrograph. The stigmatic focusing apparatus has first order double focusing for all masses and second order double focusing for one mass at the middle of the plane mass scale. With this apparatus problems of the abundances of the fission products, of their charge stages, energy spreads, and radioactive decays will be studied. (auth)

38979 HIGH SENSITIVITY ISOTOPIC ANALYSIS USING THE ARGONNE 100-INCH RADIUS DOUBLE-FOCUSING MASS SPECTROMETER. C. M. Stevens, J. Terandy, G. Lobell, J. Wolfe, R. Lewis, and N. Beyer (Argonne National Lab., Ill.). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 198-205(1963). (TID-14075; UAC-5400)

Two factors important in high sensitivity isotopic analysis are instrument transmission and background ion currents. The Argonne 100-in.-radius double-focusing mass spectrometer has 95% transmission for the usual ionization sources with a resolution of 10^4. Impurity ions of the same mass number as a nuclide being analysed for, even in the high mass range, will in general be resolved, permitting ion current detection and isotope identification close to electron multiplier background noise level. The instrument uses a modified Mattauch–Herzog focusing arrangement with spherical electrostatic analyzer. The parameters are $\phi_e = 75°$, $\phi_m = 110°$, $\epsilon' = +36.5°$, $\epsilon'' = -35°$, $r_e = r_m = 100$ in., $1''_e = 26.8$ in., $1''_m = 24.5$ in., $\Delta = 36$ in., $R' = 547$ in. There is second-order direction focusing and partial z-axis focusing. (auth)

38980 TWO-STAGE MASS SPECTROMETERS AT ALDERMASTON. H. W. Wilson (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 206-15(1963).

A double-stage solid-source mass spectrometer (M.S.X.) at Aldermaston is described. High sensitivity was obtained by the use of high accelerating voltage, fairly large radius of curvature, counting techniques, and reduction of background. The magnets are made of soft iron and give a maximum field of over 7500 G. Another mass spectrometer, the M.S.Y., with design similar to the M.S.X. is being built. (M.C.G.)

38981 A NEW MASS SPECTROMETER FOR PRECISION MEASUREMENT OF THE $^{235}U/^{238}U$ ISOTOPIC RATIO OF UF_6. C. Brunnée (ATLAS Messund Analysentechnik

GmbH. Bremen). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 230-43(1963).

Construction and performance data of a mass spectrometer for UF_6 measurements are given. The mass spectrometer is equipped with a triple inlet system, and the UF_6 passes through the ion source as a narrow molecular beam without striking walls. The molecular beam has an aperture angle of only a few degrees. Due to a special construction of the molecular beam system, the consumption of sample material is small. The practical operating period of the ion source is not limited by contamination but by the lifetime of the cathode only, which is more than 1000 hr. The memory factor is smaller than 1.003. After pumping the sample out of the inlet system, the ion current falls to below 0.03% within 20 sec. The measuring accuracy for the isotopic ratio of normal samples is ±0.02%. (auth)

38982 TWO NEW MASS SPECTROMETERS. D. Charles and J. Vastel (C.S.F. Compagnie Générale de TSF, Orsay, France). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 244-50(1963).

Some work was done in order to reduce the time required for the operator to perform an analysis, with a view to cutting down the cost of routine measurements. This led to the development of a small multipurpose gas analyzer and to automatization of a high mass high precision mass spectrometer devoted to isotopic analysis of uranium hexafluoride. (auth)

38983 CURRENT STATUS OF THE STATISTICAL THEORY OF MASS SPECTRA. H. M. Rosenstock and M. Krauss (National Bureau of Standards, Washington, D. C.). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 251-84(1963).

Since its inception, some ten years ago, the statistical theory of mass spectra has stimulated discussion and critical examination both of the ionic decomposition phenomena occurring in the mass spectrometer and of the content, meaning and realm of applicability of the theory itself. Recent experimental advances such as photoionization and energy-modulated electron beams led to information, which is serving as a testing ground for the theory. The principal features that were developed from this interplay of experiment and theory are reviewed and to some of the new problems that have emerged are outlined. (auth)

38984 VARIATIONS IN MASS SPECTRA WITH THE TEMPERATURE OF THE IONIZATION CHAMBER BETWEEN −150°C AND +200°C. A. Cassuto (Faculté des Sciences, Nancy). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 296-312(1963).

Measurements were made of variations of mass spectra with temperature between −150 and +200°C. Theoretical expectations are discussed. Experimental results for ethane, methane, propane, and n-pentane are presented in graphs and tables. (M.C.G.)

38985 IONIZATION-DISSOCIATION OF SOME CYCLOALKANES UNDER ELECTRON IMPACT. S. Meyerson, T. D. Nevitt, and P. N. Rylander (American Oil Co., Whiting, Ind.). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 313-36(1963).

Ionization-dissociation reactions of cycloalkanes under electron impact were deduced from mass spectra of variously labeled cyclohexane, methylcyclohexane, methylcyclopentane, and ethylcyclopentane. Label retentions in fragment ions from cyclohexane-d fit the statistical distribution expected from a highly symmetrical molecule. Those from substituted rings reflect the asymmetry of the molecules. CH_3^+ ions are not derived solely from original CH_3 groups, which, however, do contribute more heavily than do other parts of the molecule. Loss of C_2H_4 occurs chiefly from the ring in methylcyclohexane and methylcyclopentane, and solely in ethylcyclopentane. Loss of the side-chain plus a hydrogen atom to give a cycloalkene ion almost certainly occurs in the three substituted compounds. CH_3 lost from methylcyclohexane is the original side-chain. CH_3 and C_2H_5 lost from methyl- and ethyl-cyclopentanes are derived only in part from the original side-chains; each compound dissociates to $C_3H_5^+$ and the corresponding free radical by two competing paths that contribute largely as determined by ring strain and the dissociation energy of the bond to the side-chain. (auth)

38986 ION-MOLECULE REACTIONS IN MIXTURES OF ORGANIC COMPOUNDS. J. H. Beynon, G. R. Lester, R. A. Saunders, and A. E. Williams (Imperial Chemical Industries Ltd., Blackley, Manchester, Eng.). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 337-59(1963).

Examples of ion-molecule reactions were found in a number of mixtures of organic compounds. In the case of a mixture of esters, e.g., an acetate and a formate, ions are produced corresponding in mass to the addition of HCO from the formate to the acetate molecule, and to the addition of CH_3CO from the acetate to the formate molecule. Similar processes were found to occur in ester-nitrile mixtures. It was noticed that these processes occur with greater probability when an acetate forms one component of the mixture, in particular when this is n-butyl acetate or n-amyl acetate. These compounds, for instance, were found to react with certain ketones, which alone do not show any tendency to take part in ion-molecule reactions apart from the common transfer of a proton to the parent molecule. Studies were also made using mixtures in which the two molecules are quite different in size and in which one molecule contains no atoms of hydrogen and the other contains several. High resolution techniques were used to establish the identity of the secondary ions formed and their sensitivity to electron energy. It was concluded that these secondary ions are formed in synthetic processes involving interaction and rearrangement between the different species. An attempt was made to interpret these effects and to assess the relative efficiencies of transfer of energy in the probable collision processes. (auth)

38987 A RADIO-FREQUENCY MASS SPECTROMETER FOR STUDIES OF LIGHT HYDROCARBONS. J. H. Green, D. M. Pinkerton, and K. R. Ryan (Univ. of New South Wales, Kensington, Australia). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 475-8(1963).

A Bennett-type radiofrequency mass spectrometer was constructed for laboratory studies relevant to the radiation chemistry of light hydrocarbons. The spectrometer has three stages, 7- and 9-cycle drift spaces, and is constructed of metal. The precise construction and spacing of grids is described, because it is considered that this has resulted in an unusually high resolving power for this type of instrument. A maximum resolution of 77 in the mass range 20 to 40 was found in the pressure range 10^{-4} to 10^{-4} Torr. It was further observed that the focus conditions are such that the N_2^+ peak appears at an accelerating voltage within 0.7% of the calculated value. In this sense the instrument gives absolute mass determination. (auth)

38988 REACTIONS OF GASEOUS IONS. X. IONIC REACTIONS IN XENON–METHANE MIXTURES. F. H. Field and J. L. Franklin (Humble Oil and Refining Co., Baytown, Tex.). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 484-502(1963).

A study was made of the ionic and excited atom reactions occurring between xenon and methane in the ionization

chamber of a mass spectrometer. The reactions found are: $Xe^* + CH_4 \rightarrow XeCH_4^+ + e$, $Xe^+ + CH_4 \rightarrow XeH^+ + CH_3$, $Xe^+ + CH_4 \rightarrow XeCH_3^+ + H$, and $Xe^+ + CH_4 \rightarrow XeCH_2^+ + H_2$. The ions XeC^+ and $XeCH^+$ were also formed, but by unknown reactions. In the first reaction Xe^* represents an Xe atom excited to an energy about 0.5 ev beneath the Xe ionization energy. This reaction is similar to that observed both in this work and other work for the formation of dimers of the rare gas ions, viz., $Xe^* + Xe \rightarrow Xe_2^+ + e$. Ionization efficiency curves were determined for the several ions, and those for Xe_2^+ and $XeCH_4^+$ exhibited a sharp maximum about 2 ev above onset. This is compatible with the formation of these ions from an excited neutral reactant, that is, the ionization efficiency curve is an excitation function. Rate constants were determined for the formation of XeH^+, $XeCH_3^+$, and $XeCH_2^+$, and the values are 3.8×10^{-11}, 2.2×10^{-12}, and 4.5×10^{-13} cc/mol sec, respectively. Relative rate constants for the formation of Xe_2^+ and $XeCH_4^+$ were also obtained. Xe^* reacts with Xe nine times more rapidly than it does with CH_4. No net charge exchange between xenon and methane was observed, but no reason can be advanced for this somewhat unexpected behavior. A preliminary report of observations of reactions between xenon and O_2, C_2H_2, and H_2O is given. (auth)

38989 APPLICATION OF A TIME-OF-FLIGHT MASS SPECTROMETER TO THE EXAMINATION OF ION-MOLECULE INTERACTIONS. J. B. Homer, R. S. Lehrle, J. C. Robb, M. Takahasi, and D. W. Thomas (Univ. of Birmingham, Eng.). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 503-21(1963).

A Bendix time-of-flight mass spectrometer was modified so that the usual electron beam may be replaced by a beam of positive ions from an auxiliary source. These bombarding ions may be given any chosen energy up to 2000 ev, and enter into the field-free region of the source of the time-of-flight spectrometer, where they may interact with a sample entering through the normal gas inlet. Systems were examined in which the bombarding ion may remove an electron or abstract a hydrogen atom from the sample molecule. In the former case dissociative ionization was frequently observed. An attempt was made to relate the probability of the possible interaction processes to the internal and translational energies of the ions involved. (auth)

38990 RECENT WORK WITH THE ELECTROSTATIC ELECTRON SELECTOR. L. Kerwin, P. Marmet, and E. M. Clarke (Laval Univ., Quebec and Saint Francis Xavier Univ., Nova Scotia, Can.). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 522-6(1963).

Mass spectral studies were made of H_2^+, NO^+, N_2^+, and Ar^+ using an electrostatic electron selector. (auth)

38991 AN ELECTROSTATIC PARALLEL-PLATE ELECTRON-ENERGY SELECTOR FOR DETERMINATIONS OF CRITICAL IONIZATION POTENTIALS BY ELECTRON IMPACT. D. A. Hutchison (Argonne National Lab., Ill.). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 527-39(1963). (TID-13560)

An ion source employing an electron beam of narrow energy spread is described. The method of beam-energy selection and analysis consists of passing the beam through an electric field determined by a potential placed across two plane-parallel conducting plates. A selected electron beam of 10.0 ev energy was found to have an energy distribution with a 0.063 ev width at half-peak value. The ion source was used with a 12-in. radius 60°-sector type of direction-focusing mass spectrometer. A method for electronically differentiating an ion-appearance-potential curve is presented. Initial data are presented for formation of Ar^+ near its appearance potential as a test of the efficacy of the instrumentation. A tentative explanation of the results is presented. (auth)

38992 CARBON SUB-OXIDE. R. Botter (Commissariat à l'Énergie Atomique, Saclay, France). Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 540-54(1963).

The mass spectrum of C_3O_2 and the appearance potentials of its fragments were measured. Where comparison is possible, the values found are compatible with the values calculated by means of the existing physicochemical data, and values for other fragments are presented for which no previous data were found. (auth)

38993 BIBLIOGRAPHY ON MASS SPECTROMETRY, PERIOD MAINLY FROM JANUARY 1958 TO DECEMBER 1960. Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 561-610(1963).

A bibliography, containing 887 references and covering the period from Jan. 1958 to Dec. 1960, is presented. References are grouped by chronological order under the following headings: instruments; components and accessories; operating techniques; isotopic analysis of solids; determination of atomic masses; isotopic analysis of gases; applications to organic chemistry; ionization and dissociation of molecules; general applications in engineering, physics, and physical chemistry; spark source; and thermodynamic studies. (M.C.G.)

38994 MODERN TRENDS IN ACTIVATION ANALYSIS. Proceedings, 1961 International Conference, College Station, Texas, December 15-16, 1961. Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 1-177. College Station, Tex., A & M College of Texas, [1961]. 177p. $15.00.

Thirty two papers presented at the 1961 International Conference on Modern Trends in Activation Analysis are given. Separate abstracts were prepared for 21 of the papers. Eleven papers were previously abstracted for NSA. (M.C.G.)

38995 ABSOLUTE DISINTEGRATION RATES BY GAMMA RAY SPECTROSCOPY AND COMPUTER ANALYSIS. W. R. Morgan (General Electric Co., Pleasanton, Calif.). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 16-18.

In order to use resonance detectors it was necessary to determine the absolute disintegration rates of the isotopes. Gamma spectroscopy was selected to allow discrimination against impurities and competing reactions by analyzing energy as well as half life. The gamma spectrometer consists of a NaI (Tl) crystal, integrally mounted on a photomultiplier tube. Voltage is supplied to each dynode by individual batteries. The signal taken from the anode is preamplified by a cathode follower built with metallic resistors for stability. The voltage signal is pulse height analyzed. To determine absolute efficiencies of the system for various gamma energies, five sources of different energies and known disintegration rates were counted in the series of geometries to be used. The observed distributions were fitted by a digital computer code to a gaussian curve by a weighted least-squares technique. To establish a consistent method of determining the photopeak area, each gaussian curve was integrated from minus infinity to plus infinity. The gamma spectrum of the elements activated was recorded and the photopeak count-rate was used in conjunction with branching ratio data to determine the disintegration rate. Coincidence losses were accounted for by counting at various positions. Neutron capture rates at the resonance energy were deduced from these disintegration

rates, together with available data on the parameters of the resonance, the 2200-m/sec cross section, and a separate measurement of the 1/v flux by means of copper wires. To check the reliability and internal consistency of the entire resonance-activation technique, a set of wires was activated in an equilibrium graphite spectrum, and the indium and gold activation rates were taken as standards against which the activation rates of the other materials were compared. (auth)

38996 SELECTION OF A SET OF RADIOACTIVANTS FOR INVESTIGATING SLOW NEUTRON SPECTRA. J. G. Carver and W. R. Morgan (General Electric Co., Pleasanton, Calif.). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 19-23.

Certain features of the slow neutron spectrum within an operating reactor can be determined by activating a set of foils or wires, each of which possesses a distinct, prominent capture resonance. The principal requirements for a useful radioactivant include: the parameters of the dominant resonance must be known to a useful degree of precision; the dominant resonance should produce at least one-third of all the activations occurring in typical neutron spectra of interest; the radioactive isotope produced must be readily distinguishable from other activities produced in the material; the radioactivity produced should be readily measurable; and it must be possible to fabricate the material in a form which can be handled and counted readily. One requirement is satisfied if the material is monoisotopic or if competing reactions produce stable isotopes, isotopes with half lives drastically different from that of the isotope being measured, or isotopes occurring with very low yield. The decay should yield a gamma ray of energy greater than about 0.25 Mev with a half life in the range one hour to one hundred days. The application of these criteria led to the selection of the following ten materials for activation studied at this Laboratory: Lu, Eu, Ir, In, Au, W, Se, As, La, and Cd, with resonance energies covering the range from 0.143 to 120 ev. Each of these elements was separately alloyed, at low concentrations, in high-purity aluminum, and the alloys were drawn into 20-mil wires for ease in insertion in the Vallecitos Boiling Water Reactor. The concentrations are so chosen that all the the wires are "thin" for neutrons of all energies, to minimize the flux perturbation produced by the presence of the wire. Predicted activation patterns in typical spectra are presented and compared with experimental results where available. Sources of error and methods of analysis will be discussed. (auth)

38997 NEUTRON ACTIVATION ANALYSIS OF OXYGEN IN BERYLLIUM. J. H. McCrary (Texas Nuclear Corp., Austin), I. L. Morgan, and L. L. Baggerly. Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 24-7.

Since it was difficult to measure trace quantities of oxygen in beryllium by chemical methods activation analysis was tried in an attempt to develop a satisfactory technique for performing this measurement. The method which appears to be most promising is to activate the oxygen in the beryllium samples through the $O^{16}(n,p)N^{16}$ reaction with fast neutrons. The N^{16} decays with beta emission in a half life of 7.4 seconds to excited states of O^{16}. The excited states of O^{16} decay instantly to the ground state with the emission of 6.13 and 7.10 Mev gamma rays. Fast (14 Mev) neutrons are produced through the $T(d,n)He^4$ reaction with a 150-kev Cockcroft-Walton accelerator. A rapid transfer system moves the irradiated sample from the region of the accelerator target to a well-shielded NaI (Tl) gamma spectrometer in a time short compared to the half life of the N^{16} activity. The gamma spectrum from this detector is displayed on a multi-channel analyzer. The number of counts registered in the 6 and 7 Mev region of the spectrum is proportional to the oxygen content of the beryllium sample. This activity is compared with the activity of a standard sample irradiated and counted in the same geometry as the beryllium sample. From these data the mass of the oxygen contained in the beryllium sample was calculated. (auth)

38998 FAST NEUTRON ACTIVATION ANALYSIS WITH A PORTABLE SOURCE. Howard I. Oshry (Lane-Wells Co., Houston, Tex.). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 28-31.

Preliminary experiments carried out with a portable source of 14 Mev neutrons indicated that fast neutron activation even with moderate flux densities offers a useful technique for non-destructive analysis of the lighter elements. By combining studies of the radioactive decay of the induced activity as a function of time with studies of the spectral energy distribution of the radiations, it is possible to make qualitative and quantitative analyses of complex mixtures. The optimum analytical routine differs for different sample constituents but basically it consists of comparing with standard spectra the spectrum of the unknown after various irradiation times and various delays after irradiation. The standards are prepared by irradiating pure samples of each element of interest with a high neutron flux and observing the spectra from these samples at various intervals after irradiation. The advantages of the method lie in the fact that a small inexpensive neutron source is employed; and elements such as oxygen and silicon can be detected more readily than with pile neutron activation due to high threshold reactions which are induced much more efficiently by 14 Mev neutrons than by fission neutrons. (auth)

38999 DETERMINATION OF SUB-MICROGRAM AMOUNTS OF SOME HEAVY ELEMENTS IN METEORITES BY ACTIVATION ANALYSIS. W. D. Ehmann (Univ. of Kentucky, Lexington). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 41-5.

Results of over 100 activation analyses for the elements tungsten, tantalum, and iridium in meteorites are reviewed. The experimental techniques used in this work include irradiation of one gram samples, together with flux monitors, in the Argonne CP-5 reactor. Following irradiation, the element to be determined is extracted from the sample by use of specific radiochemical separation techniques. Counting is done by means of gamma scintillation spectrometry, using a recording single channel analyzer coupled to a NaI detector. In some cases beta counting is also done. The methods of photopeak-area integration and the observed advantages of the scintillation counting technique are discussed. Sources of error due to sampling techniques, pre-irradiation contamination, self-shielding, and radiochemical impurities are reviewed briefly, as related to the work on the three elements in question. Some implications of the results to theories of nucleosynthesis and to the origin of the meteorites are discussed. (auth)

39000 NEUTRON ACTIVATION ANALYSIS FOR CHARACTERIZATION OF INDUCED ACTIVITY IN IRRADIATED FOODS. Paul Kruger and Irwin J. Gruverman (Nuclear Science and Engineering Corp., Pittsburgh). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961. 46-9.

Twenty-one different foods were irradiated to sterilization in a spent fuel element gamma-irradiation facility as part of a program to determine the extent of induced activity in irradiated foods. Neutrons are produced in spent fuel element facilities and are expected to produce induced

radioactivity in irradiated materials. However, the levels of induced radioactivity are generally too small for radiochemical characterization. To assist in the analysis of the gross decay curves obtained for the twenty-one irradiated foods, activation analysis of one of these was performed to determine the important elements contributing to the neutron-induced activation. Chicken was chosen as representative of the foods under study, and a sample was homogenized and ashed to ensure reproducible samples and to reduce the irradiation volume required. Two irradiations were performed to investigate separately the short-lived and the long-lived activation products. The samples were irradiated together with comparators, blanks, and flux monitors in the Brookhaven National Laboratories at thermal neutron fluxes of 6.5×10^{12} and 1.3×10^{13} n/cm^{2}sec, respectively. After irradiation, the samples were analyzed for the individual elements by standard radiochemistry procedures and by material balances of the gross induced beta and gamma activities. The results showed that 10 elements account for more than 90% of the neutron-induced activity, with calcium and phosphorus predominating. The sulfur concentration was determinable only as an upper limit because of the large contribution to the S^{35} activity from chlorine by the (n,p) reaction. The data enabled the characterization of the twenty-one irradiated foods to be made and demonstrated the applicability of the activation analysis technique for determining both major and trace constituents of foods. (auth)

39001 HIGH SENSITIVITY GAMMA RAY SPECTROMETRY. R. W. Perkins (General Electric Co., Richland, Wash.). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 50-8. (HW-SA-2344)

The ultimate sensitivity provided by activation analysis depends on the sensitivity of the counting equipment used in measuring the product nuclei. Gamma spectrometric methods were investigated with the aim of optimizing both sensitivity and selectivity in radioisotope measurements. The response of three high-sensitivity gamma spectrometer systems is discussed. The first system is a summing coincidence spectrometer which uses two large opposing crystals as detectors. The crystals sandwich the sample between them for the measurements. The signals from the two detectors are summed to provide a "sum spectrum" and are also coincidence analyzed to determine if the pulse has resulted from two or more gamma rays striking the two crystals. The spectrometer system thus permits a sum spectrum and a coincidence sum spectrum to be recorded simultaneously. The sum spectrum is due mainly to radioisotopes emitting one gamma ray per disintegration while the coincidence sum spectrum is due to radioisotopes which emit two or more gamma rays per disintegration. This system aids in the analysis of a mixture of radioisotopes by separating them into two groups characteristic of their decay mode and providing a very low counting background in the coincidence sum mode of operation. The second type of spectrometer system employs a large phosphor surrounding the principal detector and operating in anticoincidence with it. The sample to be measured is placed on top of the principal detector (or in its well). The gamma rays which strike the principal detector but are not completely absorbed are "seen" by the anticoincidence guard phosphor and are canceled. This type of detector system results in a large reduction in the Compton response and in the background. The third spectrometer system employs the same two detectors as in the system described above, in addition, the sample is sandwiched in a small plastic phosphor (or in a scintillating gel medium) which is located in the well of the principal detector and is viewed with a small phototube. For an event to be stored by the analyzer, a pulse must be received from the small plastic phosphor (indicating that a beta particle was emitted) and there must not be a pulse from the guard crystal. In addition to the advantages provided by the second system, this system discriminates against non-beta emitters and provides approximately a hundred-fold background reduction over that available with the second system. (auth)

39002 ACTIVATION ANALYSIS TRAINING AT THE OAK RIDGE INSTITUTE OF NUCLEAR STUDIES. H. H. Ross and R. P. Gardner (Oak Ridge Inst. of Nuclear Studies, Tenn.). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 64-6.

The Special Training Division of the Oak Ridge Institute of Nuclear Studies was organized in 1948. The purpose of the Division is to present beginning and advanced instruction in radioisotope techniques to members of governmental, industrial, and educational institutions. Since its inception, the Division has placed a large and growing emphasis on activation analysis. Some of the more important aspects of this program and the facilities are described. (auth)

39003 THE USE OF REACTIONS INDUCED BY ACCELERATED PROTONS, DEUTERONS, HELIONS AND GAMMA PHOTONS IN RADIOACTIVATION ANALYSIS FOR THE DETERMINATION OF OXYGEN, CARBON, AND NITROGEN IN METALS. P. Albert (CNRS, Vitry sur Seine, France). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 78-85.

Irradiation by thermal neutrons (10.02 ev) permits very sensitive determination of some sixty elements. In certain cases it may be advantageous to irradiate with fast neutrons of energy greater than 1 Mev. However, certain elements such as oxygen, carbon, nitrogen, and boron, which are of great importance, particularly in metallurgy, cannot be determined by irradiation with the thermal neutrons or the fast neutrons of nuclear reactors. On the other hand, numerous researchers have already shown the possibility of determining these elements in metals. The various methods tried for these determinations are described, together with the results which were obtained. The difficulties that are encountered in the operation of these determinations are discussed together with the principal sources of errors already apparent or to be expected. (auth)

39004 A COMBINATION OF CHEMICAL AND PHYSICOCHEMICAL METHODS FOR A SYSTEMATIC SEPARATION OF LARGE NUMBERS OF RADIOISOTOPES ON ONE EXPERIMENTAL ANALYSIS OF ALUMINUM, IRON, AND ZIRCONIUM BY RADIOACTIVATION. P. Albert (CNRS, Vitry sur Seine, France). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 86-94.

The possibility of the systematic analysis of aluminum, iron, and zirconium by radioactivation was studied. A first approach used suitably chosen, successive, chemical separations to permit the separation of the radioactive isotopes formed during the irradiation into the five chemical groups of classical analysis. Tracer techniques, together with distillation, extraction, absorption, ion exchange, and selective precipitation by classical organic reagents, are used to isolate successively the radiochemical isotopes. Each principal group, which is thus identified by numerous chemical criteria and the various nuclear characteristics, is then determined. A second approach is intended to allow more quantitative, more rapid, and more automatic separations leading to a rapid quantitative analysis of minor residual impurities in common or nuclear metals. Extrac-

tion and ion exchange are being used. The use of the gamma ray spectrometer and a multichannel analyzer permits the improvement of the method of identification. The systematic analysis of very small quantities of impurities (0.01 to 1 ppm) in aluminum, iron, and zirconium which were purified by zone refining was studied. (auth)

39005 A SYSTEM FOR THE CONTROL OF DRIFT IN A MULTI-CHANNEL GAMMA RAY SPECTROMETER. L. E. Fite, D. Gibbons, and R. E. Wainerdi (A. and M. Coll., College Station, Tex.). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 102-6.

A drift control system is described which is capable of correcting for the drift in a multi-channel gamma spectrometer. The system corrects both for the over-all drift due to gain changes, and for the zero-point drift which is apparent in some multi-channel analyzers. Two radioactive sources were used as energy standards and the ferrite ore core memory of the analyzer was monitored to determine if the resulting peaks were located in the correct channels. If not, the high voltage to the photomultiplier, and/or the lower discriminator setting were adjusted by a servo-system to bring the peaks into the correct channels. Various sources of drift in a gamma spectrometer are discussed, together with the effectiveness of the control system in making corrections. The drift control system described is capable of maintaining the spectrometer within one channel of calibration. (auth)

39006 ACTIVATION ANALYSIS IN FORENSIC INVESTIGATION. R. E. Jervis (Univ. of Toronto), A. K. Perkons, W. D. Mackintosh, and M. F. Kerr. Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961. 107-13.

Neutron activation was applied in a number of cases to evaluate possible toxicity or death as a result of exposure to arsenic and other toxic metals. Radiochemical isolation of As^{76} from irradiated tissues was performed and analysis at a level of 10^{-10} g of arsenic were precise to better than 10%. The arsenic content of similar tissues from healthy individuals was compared to those found in the suspect cases. Considerable variation in As content from one individual to another was evident in these analyses, and this was also found for the content of Cu, Na, and other trace elements in human tissues. As a result of these findings, a study was made of the possibility of establishing biological individuality from trace element analyses by activation techniques. Analyses of hair and blood were carried out, primarily by gamma ray spectrometry of irradiated specimens and one of fractions from a systematic radiochemical separation scheme. The results of this study indicated that there is a characteristic pattern of trace element concentrations in different individuals, which presumably reflects dietary, metabolic, and geographical effects. On the same basis, the analysis of soils, metals, and papers has indicated similar differences which can also be used in forensic investigation for establishing the origin or identity of materials derived from the soil or rocks, and which incorporate characteristic trace elements such as natural fibers, narcotics, metals from a particular refiner and from a particular batch, etc. Similar results have currently been reported as a result of a study of trace element contents in synthetic fibers. (auth)

39007 ACTIVATION RESEARCH IN THE AEROSPACE INDUSTRY. M. L. Rossi, M. D. D'Agostino, J. W. Nostrand, Jr., and A. J. Favale (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 114-18.

Activation research provides a means for the investigation of induced activity problems which confront the aerospace industry. Its basic techniques and methods are those used in standard activation analysis; however, their use is toward different goals. Instead of seeking elemental composition of materials, the activation research program was more concerned with the effects and problems associated with induced activity. The results obtained from and the techniques used in the investigation of some nuclear-space problems are discussed. The dose rates resulting from vehicle structure activation were investigated. An analytical study of the dose rates expected from a space vehicle exposed to solar flare proton radiation was made. Experimental work has consisted of fission neutron activation of various types of materials. A more convenient method for calibrating U^{235} fission spectrum neutron fluxes was developed using a modification of the sulfur-phosphorus technique. A special IBM 704 computer program, which utilizes a method of least squares fit for analyzing decaying complex gamma spectra data from a multi-channel pulse height analyzer was written. In addition, several U^{235} fission neutron activation cross sections were verified and measured. The problem of possible contamination of a space vehicle's food supply through activation was studied. An analytical investigation was made to determine the cross sections required to produce concernable levels of contamination. The change in conductivity of a semiconductor material as a result of impurity atoms introduced through activation was investigated. This work included the computer programing of the solution of the build-up and decay equations which are used to compute the number of atoms of each isotope in a decay chain as a function of time during and after irradiation. (auth)

39008 DEVELOPMENT OF NEW TECHNIQUES OF ACTIVATION ANALYSIS AT THE COMMUNITY RESEARCH CENTER OF EURATOM-ISPRA. F. Girardi (C.C.R. Euratom, Ispra, Italy). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 119-25.

Research progress is reported on chemical sepration of irradiated materials, determination through (n,γ) reactions and double beta decay, automation in chemical separations, and sensitivity calculations for activation analysis. (M.C.G.)

39009 NEW DEVELOPMENTS IN INSTRUMENTAL ACTIVATION ANALYSIS—ACCELERATORS AND ANALYZERS. Vincent P. Guinn (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 126-32.

The advent of the low-cost neutron generator, the multichannel pulse height analyzer, and the purely instrumental technique (based on gamma spectrometry) stimulated the growth of activation analysis. Two troublesome problems (target lifetimes and gain shifts) are discussed, with possible solutions. Some promising areas of development are outlined: reactor centers, commercial services, computer utilization, reactor fast neutrons, photonuclear reactions, stable tracers, new areas of application, and textbooks. (auth)

39010 THE WORLDWIDE DEVELOPMENT OF ACTIVATION ANALYSIS. G. B. Cook (International Atomic Energy Agency, Vienna). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 133-6.

Increased uses of activation analysis made possible by the increased number of reactors being built are discussed. Applications in studies of natural resonances, medicine, and agriculture are described. (M.C.G.)

39011 USE OF ACTIVATION ANALYSIS IN STUDIES OF SELENIUM IN THE MAMMALIAN ORGANISM. Kenneth

P. McConnell (Veterans Administration Hospital, Louisville, Ky. and Univ. of Louisville, Ky.). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 137-40.

Neutron activation analyses (NAA) were used for the determination of trace amounts of selenium in foodstuffs, and other biological materials. Application of the characteristic nuclear reaction (n,γ) was employed. An indirect method, in which a radiochemical separation of the radionuclide is performed, and a direct method, where the samples are irradiated and the radiation measured without ashing or radiochemical separation were developed. The limit of detection of selenium is about 2×10^{-8} grams and with 10 gram samples of biological materials, the lower concentration detection limit is about 2 parts per billion. NAA were useful in studies on the etiology of Lathyrism disease in man, a disease marked by muscular weakness. The method of activation analyses proved helpful in experiments evaluating the role of selenium as a constituent of metalloproteins and metalloenzyme, and in biological systems. In analytical chemistry, NAA were used to perform elementary analyses of selenium in microquantities of organoselenium compounds. Radioactivation can be used to prepare Se^{75} labeled organoselenium which will be useful in biological studies of selenium compounds, and sulfur substances of physiological significance which may be either mimicked or antagonized by their selenium analogs. NAA were used in the studies of the possible involvement of selenium in human malignancies. (auth)

39012 THE APPLICATION OF ACTIVATION ANALYSIS TO MEDICAL PROBLEMS. L. O. Plantin (King Gustaf Vth Research Inst., Stockholm). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 141-4.

Through its sensitivity and possible specificity activation analysis is a tool for studies of trace elements in blood and tissues. Some methodological work was devoted to solve the necessary problems of sampling and of getting rid of sodium. For isolation of the desired element a radiochemical purification procedure followed by γ spectrometry and chemical yield determination was employed. Methods were worked out on the basis of these steps for the determination of Cu, Zn, Cd, Mn, and Au in blood and tissues. Some results from the application of these methods to samples from healthy and diseased persons are reported. (auth)

39013 METHODICAL IMPROVEMENTS OF ACTIVATION ANALYSIS. W. Bock-Werthmann and W. Schulze (Hahn-Meitner-Institut für Kernforschung, Berlin). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 145-8.

Interfering-reactions caused by fast neutrons cannot always be neglected in activation analysis. A method is suggested which enables these errors to be avoided by irradiation of the analytical sample and the standard either with or without a cadmium screen. The sensitivity of the analysis is not decreased significantly by this method, whereas irradiation in a reactor position of almost pure thermal flux would involve a lower neutron flux and therefore a poorer sensitivity. This technique is discussed for the determination of sodium in pure aluminum. The separation of different radionuclides is another problem. For nuclides with half lives differing by an order of magnitude, this separation can be made easily and rapidly by using the complement-subtraction method. The γ spectrum of such a nuclide mixture is accumulated in the electronic memory of a multi-channel analyzer, is complemented, and (by adding subsequent recomplementing) the long-lived activities subtracted after a decay of approximately one half life of the short-lived nuclide. During this procedure, the analytical sample remains in place on the detector. The photopeak of the nuclide with a short half life usually appears as the difference between the two spectra. This method was used for the determination of aluminum in terphenyl in the presence of manganese, sodium, copper, and chloride. The counts recorded corresponding to the aluminum photopeak can be used directly for the calculation of the amount of aluminum. This method, therefore, also has the advantage of saving time. The possibility of errors arising due to air trapped in wrappings (polyethylene foils, etc.) is also mentioned. The argon content of the air is responsible for this effect. It can be shown that 1 ml of air gives rise to about 33 microcuries of induced activity at a flux of 10^{13} neutrons/cm^2/sec. (auth)

39014 THE DEVELOPMENT OF A SPECTRUM CATALOGUE AND DATA PROCESSING TECHNIQUES FOR THE GAMMA RAY SCINTILLATION SPECTROMETER. R. L. Heath (Phillips Petroleum Co., Idaho Falls, Idaho). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 155-60.

Standard measurement techniques which permit rapid quantitative gamma spectroscopy in the routine laboratory are being developed. Investigations were directed to the improvement and extension of the Gamma Ray Spectrum Catalog. Photofractions for various size crystals were determined with improved precision and the detector response to monoenergetic gamma sources were determined with high precision. Particular attention was given to bremsstrahlung, equipment stability, detector resolution, scattering geometry, and absorbing materials introduced to attenuate unwanted radiation. The results of these studies are presented. Computer programs were developed which permit the calculation of the complete pulseheight distribution for a given nuclide for any detector. This requires only a knowledge of the decay scheme for the nuclide in question and the measurement parameters for the detector being used. This, in effect, permits the calculation of a complete gamma spectrum catalog for any detector and set of experimental conditions. A simple automatic data handling system will be described which permits direct quantitative analysis of complex spectra in the pulseheight analyzer itself, using information contained on catalogs of perforated tape. The need for standards in the field of experimental gamma spectroscopy is discussed. (auth)

39015 THE ACTIVATION ANALYSIS PROGRAM AT THE DIVISION OF NUCLEAR CHEMISTRY AND THE ISOTOPE TECHNIQUES LABORATORY IN STOCKHOLM. R. Christell (Royal Inst. of Tech., Stockholm). Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex., 1961, 172.

Methods and uses of activation analyses at the Stockholm Royal Institute of Technology and the Isotope Techniques Laboratory are discussed. (M.C.G.)

Inorganic and Physical Chemistry

Refer also to abstracts 39400 and 40395.

39016 (AAEC/TM-211) ADAPTATION OF THE SIEMENS DIFFRACTOMETER FOR PRECISION LATTICE PARAMETER DETERMINATIONS OF SINGLE CRYSTALS. R. M. Mayer and D. G. Walker (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Aug. 1963. 9p.

Modifications to the Siemens diffractometer that permit precision lattice parameter determinations on single crys-

tals are described. Analysis of the errors and consideration of the results suggest that accuracies of about 1–2 parts in 10^5 are obtained on small beryllium oxide crystals. Details of alignment and measurement procedure are included. (auth)

39017 (ANL-6684) THE MECHANISM AND KINETICS OF THE REACTION BETWEEN NICKEL AND FLUORINE. R. L. Jarry, W. H. Gunther, and J. Fischer (Argonne National Lab., Ill.). Aug. 1963. Contract W-31-109-eng-38. 29p.

The mechanism and kinetics of the nickel-fluorine reaction were studied. Tracer experiments, in which radioactive nickel-63 was studied, and scale-impingement experiments, in which two scales formed during the reaction were forced to impinge upon each other, were carried out to determine whether nickel or fluorine migrates through the nickel fluoride scale formed during the fluorination of nickel. Similar experiments were performed with the nickel-oxygen system to verify the experimental results obtained in the nickel-fluorine study with those obtained in a reaction of known mechanism. The radioactive tracer experiments indicated that fluorine migrates through the growing fluoride scale. This was shown by the lack of movement of the radioactive tracer, which was found at the nickel fluoride scale-fluorine gas interface. In the nickel-oxygen experiments, the radioactivity was found to be distributed through the oxide scale in a manner predicted from the known mechanism. This result was in accord with the accepted mechanism for that reaction, namely, that nickel migrates through the nickel oxide scale to the nickel oxide-gas interface. In the fluoride scale-impingement experiments, the existence of an interface between the two scales growing from opposing surfaces indicated that fluorine is the migrating species. In the oxide scale-impingement experiments, a continuous scale was formed, thereby indicating that nickel is the migrating species in this case. The kinetics of the nickel-fluorine reaction were studied between 300 and 600°C using high-purity and commercial nickel. The parabolic rate constants for the reaction with high-purity nickel were found to be 9.8, 81, 461, and 1860 (μg F_2/sq cm)^2 per minute at 300, 400, 500, and 600°C, respectively. No significant difference in reaction rates for the two types of nickel was noted except in the initial portion (less than 500 min) of the reaction period. The parabolic rate was found to be independent of the pressure of fluorine over the range of 100 to 700 mm Hg when the thickness of the nickel fluoride scale was 10^4 Å or less. After a scale having a thickness of about 10^5 Å has been deposited, the rate of scale formation was found to vary with the one-half power of the fluorine pressure. (auth)

39018 (AWRE-0-55/63) GROWTH OF SMALL IONS IN SUPERSATURATED WATER VAPOUR. P. J. Hutton (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Oct. 1963. 28p.

The growth of positive hydrogen ions during controlled exposures to water vapor was investigated experimentally. The ions were drawn by a uniform electric field across a jet of supersaturated vapor, formed by the expansion of saturated vapor through a nozzle. The distance they were swept downstream was found from the position of that electrode of a series which collected them. The time spent by the ions in the vapor was determined from this distance and the streaming velocity of the jet. From this exposure time and the field strength, and the pressure of vapor in the jet and its width, the mean mobility of the ions was calculated. Oswatitsch's theory of the rate of growth of droplets in a pure vapor is extended to the case of ions, by assuming that even a small ion in a vapor can be treated as a charged liquid droplet, and taking account of the influence of its charge on its collision frequency with vapor molecules. The ion's size is derived as a function of the product of exposure time and vapor pressure. Using Langevin's theory of mobility its mean mobility during the exposure is predicted. The predicted and measured mobilities agree, showing that the experimental results are consistent with the assumption that the ions grow by attaching single molecules. (auth)

39019 (BNL-6722) STUDY OF LOW-FREQUENCY MOLECULAR MOTIONS IN HF, KHF_2, KH_2F_3 AND NaH_2F_3. Henri Boutin, G. J. Safford (Brookhaven National Lab., Upton, N. Y.); and Velko Brajovic (Institut za Nuklearne Nauke "Boris Kidric," Belgrade). [1961]. Contract AT-30-2-GEN-16. 23p.

The spectra of KHF_2, KH_2F_3, NaH_2F_3, liquid and solid HF were measured between 1200 and 30 cm^{-1} by the inelastic scattering of "cold neutrons" (0.005 ev). The spectrum of KHF_2 is in agreement with previous infrared measurements and shows a peak at 147 mv corresponding to a deformation frequency ν_2 of the F-H-F group and a broad peak at 13 mv due to a libration of this group. The observed spectra for KH_2F_3, NaH_2F_3, solid and liquid HF were compared with that for KHF_2 considering the known results that the F-F distance increases, the position of the H atom between the two fluorines becomes more asymmetrical, and the strength of the hydrogen bond decreases in going from the HF_2^- ion to $H_2F_3^-$ ion to HF. In this comparison the known structure of the $H_2F_3^-$ ion is considered as being intermediate between that of HF_2^- and the zig-zag hydrogen bonded chains in solid HF. As a result, the lines observed at 112 and 67 mv in the $H_2F_3^-$ spectra and in HF respectively are associated with the deformation frequency ν_2 of the H-F-H group in these compounds. In addition the spectra of $H_2F_3^-$ ions show a peak at a 15 mv attributed to a libration of the group. Both $H_2F_3^-$ and HF show peaks at 8 and 7 mv respectively attributed to a rotational motion of one F-H-F unit around the F-F bond. The observed spectrum of HF liquid, showing a high degree of association, is also discussed with respect to these motions. (auth)

39020 (BNL-6741) YTTERBIUM AND TERBIUM DODECABORIDES. Sam La Placa, Daniel Noonan (Brookhaven National Lab., Upton, N. Y.); and Ben Post (Brooklyn. Polytechnic Inst.). [Feb. 12, 1963]. Contract [AT (30-2)-Gen-16]. 8p.

In the reported synthesis of several rare earth dodecaborides from metal oxides and boron, TbB_{12} and YbB_{12} were among the borides which could not be prepared. Efforts were made to synthesize YbB_{12}, TbB_{12}, and GdB_{12} using the pure metals which were arc melted with boron under argon. YbB_{12} and TbB_{12} were obtained as face-centered cubic phases with respective lattice constants of 7.469 and 7.504 A, while only GdB_6 was obtained from Gd. Crystallographic data for the new dodecaborides are tabulated along with these for the other rare earth dodecaborides. (D.L.C.)

39021 (IS-665) STUDY OF A GRAPHITE–OXYGEN HIGH-TEMPERATURE FUEL CELL. Frederick R. Duke and James L. Copeland (Ames Lab., Ames, Iowa). Aug. 1963. Contract W-7405-eng-82. 11p.

An attempt was made to determine electrochemically the high-temperature thermodynamic functions for CO_2 formation. Three electrolyte systems were used in conjunction

with graphite and oxygen electrodes: $Na_2MoO_4-MoO_3$, $Na_2WO_4-WO_3$, and $Na_2B_4O_7-B_2O_3$. The $Na_2MoO_4-MoO_3$ system failed because of reduction of MoO_3 to Mo by graphite. For $Na_2WO_4-WO_3$, the variation of emf with CO_2 partial pressure at 800°C and the temperature dependence of emf were measured and found to deviate considerably from the theoretical values. Preliminary results are also reported for the $Na_2B_4O_7-B_2O_3$ system; studies of this system were not completed because of failure of the Vycor gas delivery tubes. (D.L.C.)

39022 (LAMS-2952) THE SOLUBILITY OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. II. TANTALUM. D. F. Bowersox (Los Alamos Scientific Lab., N. Mex.). July 18, 1963. Contract W-7405-eng-36. 11p.

The solubility of tantalum in liquid plutonium was measured over the temperature range 700 to 1000°C. The solubility increases from 45 ppm (by weight) Ta at 750°C to 1070 ppm Ta at 1000°C. The data fit the emperical equation $\log N_{Ta} = 3.06 - 7.50 \times 10^3\ T^{-1}$, where N_{Ta} is the solubility of Ta expressed as the mole fraction and T is the temperature in degrees Kelvin. (auth)

39023 (NP-13125) ISOTOPE SHIFT AND HYPERFINE STRUCTURE. Final Report. John R. Holmes (University of Southern California, Los Angeles). Aug. 31, 1963. Contracts Nonr-228(III) and Nonr-228(14). 16p.

The experimental apparatus and procedures used to investigate isotope shifts in heavy elements are briefly reviewed, and the information that can be derived from the data is indicated. Reasons and aids for further research are also given. (D.C.W.)

39024 (PAN-425/XIV) ULUCHSHENNYI METOD OPREDELENIYA RABOCHEI OBMENNOI EMKOSTI I KINETICHESKIKH KHARACTERISTIK IONITOV. (Convenient Method for Determination of Operational Exchange Capacity and of Kinetic Characteristics of Ion Exchange Resins). Teresa Zelin'skaya (Polish Academy of Sciences, Inst. of Nuclear Research, Warsaw). Apr. 1963. 19p.

A convenient method for studying the kinetics of ionic exchangers is described. Both cation- and anion-exchange resins can be evaluated in sodium chloride solutions of $1 \cdot 10^{-4}$ to $2 \cdot 10^{-2}$ molarity and with pH values fixed in the region 5 to 9. Classified beds of screen-analyzed resins were used with effective particle size of 0.5 to 0.6 mm. Commercial-grade cationic and anionic exchangers were also studied. (auth)

39025 (TID-19360) PREPARATION AND STRUCTURE OF SOME MIXED LITHIUM RARE EARTH COMPOUNDS. Karl S. Vorres (Purdue Univ., Lafayette, Ind.). [1962]. Contract [AT(11-1)-1246]. 5p. (CONF-20-22)

From 3rd Rare Earth Conference, Clearwater, Fla., Apr. 1963.

Earlier work on correlating the structures of ternary oxides was extended to ABO_2 type compounds. Studies on the preparation and structure of lithium rare-earth oxides indicate compound formation for dysprosium and all heavier rare earths. The $LiScO_2$ type of structure with some distortion was observed. Dietzel's rule is found to apply fairly well for the prediction of lack of compound formation. (auth)

39026 (TID-19485) THE RELATIONSHIP BETWEEN OXIDE FILMS AND ELECTRODE POTENTIALS. Annual Progress Report, September 15, 1962 to September 15, 1963. Robert C. Plumb (Worcester Polytechnic Inst., Mass.). Contract AT(30-1)-2479. 60p.

Research on the effects of oxide films on electrode potential is described. Topics covered include: the behavior of the aluminum electrode in alkaline solution, the oxidation of aluminum as measured by elliptically polarized light, the measurement of very thin films on metal surfaces by elliptically polarized light, Votta potentials and the effects of oxide films on electrode potentials, the mechanism of condensation of evaporated films, the beryllium electrode, and the oxidation of beryllium as measured with elliptically polarized light. (M.C.G.)

39027 (UCRL-7362-T) VAPORIZATION OF THE RARE EARTH DICARBIDES. Donald D. Jackson, Ray G. Bedford, and George W. Barton, Jr. (California. Univ., Livermore. Lawrence Radiation Lab.). May 9, 1963. Contract W-7405-eng-48. 18p. (CONF-221-1)

From 4th Uranium Carbide Meeting, East Hartford, Conn., May 1963.

A mass-spectrometric study was made of the vapor species that occur in the Langmuir vaporization of the solid rare earth dicarbides from resistively heated graphite filaments. It was found that, in addition to the gaseous metal atoms, there were also present gaseous MC_2 molecules as a minor species in the two-phase systems of carbon with the dicarbides of La, Ce, Pr, Gd, and Lu. This behavior is illustrated with a detailed analysis of the data for the case of LaC_2. The enthalpy of sublimation of $LaC_2(s)$ to $LaC_2(g)$ is 161 kcal/gfw; and to La(g), 130 kcal/gfw. The enthalpy of formation at temperature was calculated by two methods to be −29 kcal/gfw and −25 kcal/gfw. The temperature interval investigated was from 1966 to 2424°K, during which the ratio LaC_2/La increased from 0.17 to 0.45. (auth)

39028 (UCRL-10886) VAPOR-LIQUID EQUILIBRIA FOR AQUEOUS SULFURIC ACID. John Irving Gmitro and Theodore Vermeulen (California. Univ., Berkeley. Lawrence Radiation Lab.). June 24, 1963. Contract W-7405-eng-48. 85p.

The composition of the vapor phase over sulfuric acid has not been measured experimentally because of the low volatility of H_2SO_4. A method is described for calculating the partial pressures of H_2O, H_2SO_4, and SO_3 based upon liquid-phase partial-molal thermodynamic quantities. Tables and graphs are provided which give the above partial pressures from −50 to 400°C at thirty-six compositions between 10 and 100 weight-percent acid. (auth)

39029 (AEC-tr-6069) COMPLEX FLUORIDE COMPOUNDS OF TANTALUM AND NIOBIUM. G. S. Savchenko and I. V. Tananaev. Translated by A. L. Monks (Oak Ridge National Lab., Tenn.), from Zh. Prikl. Khim., 19: 1093-1105(1946). 29p.

In order to perfect the Marignac method of separating tantalum and niobium through their double fluoride–potassium salts, the solubility (25°) in the following systems was studied: $K_2TaF_7-HF-H_2O$ and $K_2NbF_7-HF-H_2O$. In both systems, at HF concentrations equal to 45.25% and 40.50%, respectively, the formation of $KTaF_6$ and $KNbF_6$ occurs. Both salts were separated in the pure state. The solubility (25°) in the following systems was investigated: $KTaF_6-HF-H_2O$ (HF from 42.4% to 66.5%) and $KNbF_6-HF-H_2O$ (HF from 40.9% to 59.0%). Both salts are congruently soluble in highly concentrated HF solutions. The solubility (25°) in the system $K_2TaF_7-K_2NbF_7-HF-H_2O$ (according to eutonics) was investigated. The solubility curve reproduces the properties for such a system for the $K_2NbF_7-HF-H_2O$ system. From the results obtained, optimum conditions for separating tantalum and niobium are described. Possibilities for predicting the preparation conditions of fluorotantalates and fluoroniobates of alkali

metals with a given number of fluoride molecules in an alkali metal of a double salt are presented. (auth)

39030 (SC-T-510) ELECTRON PARAMAGNETIC RESONANCE OF A PYROCARBON. Michèle Cerutti, Jean-Gérard Théobald, and Jean Uebersfeld. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Compt. Rend., 256: 3029-30(Apr. 1, 1963). 4p.

The paramagnetic resonance of a pyrocarbon plate is studied at room temperature as a function of the angle which is formed between the continuous magnetic field and the plane of the plate. From this, the properties of the resonance of an individual crystallite are deduced, as well as the mean orientation of the crystallite planes in relation to the plane of the pyrocarbon deposit. (auth)

39031 (UCRL-Trans-990(L)) BERYLLIUM NITRIDE. Fr. Fichter and Emil Brunner. Translated by Carolyn R. Hunt (Univ. of California. Lawrence Radiation Lab., Livermore), from Z. Anorg. Allgem. Chem., 93: 84-94 (1915). 14p.

Beryllium metal volatilizes at 1530° in rare hydrogen about half way in 30 minutes and condenses again in glossy little drops or little crystals. Beryllium metal absorbs nitrogen at 1000 to 1100° during formation of beryllium nitride, Be_3N_2. On account of the great sensitivity of beryllium toward oxygen, the formation of the nitride proceeds more smoothly by employing ammonia, which is for the most part decomposed at the reaction temperature of 1000°. Be_3N_2 melts by heating it quickly in a nitrogen atmosphere at 2200°, and then solidifies crystallinely. Be_3N_2 is more quickly corroded than aluminum nitride by water, by diluted acid, and by concentrated alkali-liquor. Beryllium carbide reacts almost exactly like beryllium metal at about 1250° with nitrogen, at 950 to 1000° with ammonia during formation of beryllium nitride and driving off of carbon. A mixture of beryllium oxide and carbon absorbs nitrogen smoothly at 1900°, i.e., at the temperature at which beryllium carbide is quickly produced. Beryllium forms no bonds containing nitrogen and hydrogen simultaneously, and beryllium carbide absorbs nitrogen only with giving off the equivalent amount of carbon. (auth)

39032 STIMULATED EMISSION AT 5985 Å FROM Pr^{+3} IN LaF_3. R. Solomon and L. Mueller (Varian Associates, Palo Alto, Calif.). Appl. Phys. Letters, 3: 135-7 (Oct. 15, 1963).

An emission spectrum obtained for Pr^{3+} in LaF_3 at 77°K revealed a previously unobserved stimulated emission line at 5985 Å. Examination of the corresponding absorption spectrum identified the stimulated emission as a $^3P_0 \rightarrow {}^3H_6$ transition. (D.C.W.)

39033 THERMODYNAMIC PROPERTIES OF HYDROGEN AND DEUTERIUM AT TEMPERATURES BETWEEN—175°C AND 150°C AND AT PRESSURES UP TO 2500 ATMOSPHERES. A. Michels, W. De Graaff and G. J. Wolkers (Universiteit, Amsterdam). Appl. Sci. Res., Sect. A, 12: 9-32(1963). (In English)

From compressibility isotherms of hydrogen and deuterium published previously, values of energy, enthropy, free energy, enthalpy, free enthalpy, internal kinetic energy, specific heats, speed of sound, and Joule-Thomson coefficient were calculated. The data are presented at integral values of pressure and temperature for the normal ortho-para concentrations. (auth)

39034 THE FLUORINATION OF URANIUM SULFATE WITH CHLORINE TRIFLUORIDE. N. S. Nikolaev and Yu. D. Shishkov. At. Energ. (USSR), 15: 81(July 1963). (In Russian)

A 10-g sample of $U(SO_4)_2$ was fluorinated with gaseous ClF_3 for 1 hour in a horizontal nickel reactor at temperatures of 18, 50, 100, 150, 200, 250, and 300°C. The composition of the solid residue was determined by chemical and x-ray analyses. The UF_6 yield was determined by freezing out the volatile components in a copper or quartz trap. The data show that $U(SO_4)_2$ is converted to UO_2SO_4 with increasing temperature. The content of UO_2F_2 in the solid residue also increases with the temperature. The yield of UF_6 is 75.60% at 200°, 81.30% at 250°, and 90.74% at 300°C. Uranium hexafluoride is probably formed as a result of the fluorination of UO_2F_2. The fluorination of $U(SO_4)_2$ by ClF_3 can be represented as follows: (a) $3U(SO_4)_2 + 2ClF_3 \rightarrow 3UO_2SO_4 + 3SO_2F_2 + Cl_2$; (b) $3UO_2SO_4 + 8ClF_3 \rightarrow 3UO_2F_2 + 3SO_2F_2 + 4Cl_2 + 6OF_2$; (c) $3UO_2F_2 + 8ClF_3 \rightarrow 3UF_6 + 4Cl_2 + 6OF_2$. The over-all reaction is: $3U(SO_4)_2 + 18ClF_3 \rightarrow 3UF_6 + 6SO_2F_2 + 9Cl_2 + 6OF_2$. (TTT)

39035 THE DISSOLUTION AND ANION EXCHANGE BEHAVIOR OF RARE EARTH AND OTHER METALLIC ELEMENTS IN POTASSIUM BICARBONATE, POTASSIUM CARBONATE AND AMMONIUM CARBONATE SOLUTIONS. Tomitsugu Taketatsu (Kyushu Univ., Fukuoka, Japan). Bull. Chem. Soc. Japan, 36: 549-53(May 1963). (In English)

The amounts of rare earth ions dissolved in a potassium bicarbonate solution, as well as those of other metallic ions dissolved in potassium bicarbonate, potassium carbonate and ammonium carbonate solutions, were measured. Moreover, the minimum concentrations of potassium bicarbonate, potassium carbonate, and ammonium carbonate required to dissolve the precipitates of the metallic bicarbonate and carbonate completely were determined, and the distribution coefficients, K_d, of the completely dissolved metallic ions between an anion exchange resin and a potassium bicarbonate, potassium carbonate, or ammonium carbonate solution were measured. On the basis of the findings, the dissolution and anion exchange behavior of the metallic ions is discussed, and the applicability to an analytical separation is described. (auth)

39036 TARTRATE COMPLEXES OF THE RARE-EARTH ELEMENTS. I. THE d-, dl-, AND meso-TARTRATE COMPLEXES OF Tb AND Eu. P. G. Manning (Dept. of Mines and Technical Surveys, Ottawa). Can. J. Chem., 41: 2557-65(Oct. 1963).

Solvent extraction and radiotracer techniques were applied to the study of metal-tartrate ion association in water at 25°C. Trace concentrations of the radioisotopes Tb^{160} and $Eu^{152/154}$ were equilibrated between aqueous sodium tartrate solutions and organic phases of thenoyltrifluoroacetone in toluene. The ionic strength (0.0597) and the pH (4.53) of the aqueous phase were kept constant by means of sodium perchlorate and sodium acetate. Metal complexing with the d-, dl-, and meso isomers of the ligand was examined. For all isomers two complex species were identified with metal : ligand ratios of 1 : 1 and 1 : 2, and stability constants for both stages of ion association were estimated. No third (1 : 3) complex was detected. Metal coordination numbers and the formation of tartrate–tartrate hydrogen bridges in the 1 : 2 complex are discussed. (auth)

39037 TARTRATE COMPLEXES OF THE RARE-EARTH ELEMENTS. II. THE dl- AND meso-TARTRATE COMPLEXES OF La, Ce, Pm, Tm, AND Y. P. G. Manning (Dept. of Mines and Technical Surveys, Ottawa). Can. J. Chem., 41: 2566-74(Oct. 1963).

The liquid-liquid distribution method was used to measure the stability constants of the dl-tartrate complexes of La^{3+}, Ce^{3+}, Pm^{3+}, Tm^{3+}, and Y^{3+}, and the meso-tartrate complexes of Ce^{3+} and Tm^{3+}. Thenoyltrifluoroacetone was

the organic phase extractant, and the aqueous phase, acetate buffered (pH = 4.53), was maintained at a constant ionic strength (0.0597) by means of sodium perchlorate. The order of stabilities for the two stages of ion association are $M^{3+} + L^{2-} = ML^{+}$; meso > dl and $ML^{+} + L^{2-} = ML_2^{-}$; meso < dl. The b_1/b_2 values, where b is a stepwise stability constant defined as $b_n = [ML_n^{(3-2n)+}]/[ML_{n-1}^{(5-2n)+}][L^{2-}]$, are lower (by factors of 4–8) for the dl-tartrates than for the meso-tartrate complexes. The b_1 b_2 ratios decrease as the ionic radius of the metal ion decreases, and for the dl-tartrates of Tb^{3+}, Y^{3+}, and Tm^{3+}, the b_1/b_2 values are 5.3, 5.0, and 4.3, respectively. The enhanced stabilities of the 1:2 (ML_2^{-}) dl-tartrate chelates were interpreted in terms of ligand-ligand hydrogen bridging in the 1:2 complex. (auth)

39038 A MASS SPECTROMETRIC STUDY OF THE OXIDATION OF HYDROGEN SULPHIDE. PART I. OBSERVATION AND IDENTIFICATION OF SOME INTERMEDIATES. D. G. H. Marsden (Laval Univ., Quebec). Can. J. Chem., 41: 2607-20(Oct. 1963).

The oxidation of hydrogen sulfide was followed mass-spectrometrically by direct sampling from a reaction vessel having a small leak. In the neighborhood of the third explosion limit, there is a period of 8–12 seconds of accelerating reaction before the explosion; during this time peaks are observed to grow, disappearing after explosion. By using $D_2S/^{16}O_2$ and $H_2S/^{18}O_2$ mixtures, it is shown that these peaks arise from the ions H_2^+, S_2O^+, H_2SO^+, S_2^+, and $H_2S_2^+$. It is evident that the first two ions represent the intermediate formation of hydrogen and disulfur monoxide; the parents of the last three ions are discussed, and it was concluded that the most likely possibilities are H_2SO_2, S_2, and H_2S_2. Only during the explosion itself is there any evidence for SO radical. (auth)

39039 PHYSICAL AND TECHNICAL ASPECTS OF REDUCING THE ENERGY REQUIRED FOR THE ELECTROCHEMICAL PRODUCTION OF DEUTERIUM. August Winsel (Technische Hochschule, Brunswick, Ger.). Chem.-Ingr.-Tech., 35: 379-85(May 1963). (In German)

The relatively high-energy expenditure in electrolytic deuterium enrichment can be improved when the separation effect on the individual hydrogen cathodes is improved by suitable selection of the electrode material and optimum operating conditions. A part of the electrolysis energy can be recovered by recombination of the electrolysis gases in oxyhydrogen gas elements. An electrochemical analog to a distillation column or a dual-temperature column for D_2O enrichment can be constructed in this manner. (tr-auth)

39040 STRUCTURE AND THEORETICAL SIGNIFICANCE OF NOBLE GAS COMPOUNDS. P. Hemmerich (Universitat, Basel). Chimia (Aarau), 17: 289-92(Sept. 16, 1963). (In German)

Reactions of rare gases with fluorine, the structures of the compounds formed, and their significance in the theory of the nature of chemical bonds are discussed. (M.C.G.)

39041 CRYSTAL STRUCTURES OF SILICON-RICH SILICIDES OF RARE-EARTH ELEMENTS OF THE YTTRIUM GROUP. E. I. Hladyshevskii (Lvov State Univ.). Dopovidi Akad. Nauk Ukr. RSR, No. 7, 886-8(1963). (In Ukrainian)

The roentgenographic method was used to establish the existence of the compounds Tb, Ho, Er, Tm, and Lu with Si possessing structure of the AlB_2 type, and the existence of isostructural compounds Dy and Yb with Si was confirmed. The Si content in all compounds is close to 60 at. % (defective structures RSi_{2-n}). The compounds $DySi_{2-n}$ and $HoSi_{2-n}$ are in equilibrium with the more silicon-rich compounds of the α-$GdSi_2$ type; the rest, with silicon. (auth)

39042 DEUTERIUM EXCHANGE BETWEEN DEUTERIODIBORANE AND ALUMINUM BOROHYDRIDE. P. Calvin Maybury and Joseph C. Larrabee (Eastern Nazarene Coll., Quincy, Mass.). Inorg. Chem., 2: 885-90(Oct. 1963).

The kinetics of the exchange of deuterium between diborane and aluminum borohydride were studied over a temperature range of –7 to 20°, and the orders of reaction were found to be dependent on the relative proportions of B_2D_6 and $Al(BH_4)_3$. When the pressure of B_2D_6 is less than four times the $Al(BH_4)_3$ pressure, the reaction order was found to be 0.52 with respect to $Al(BH_4)_3$ and 1.2 with respect to B_2D_6. At ratios greater than 4 the order of reaction with respect to $Al(BH_4)_3$ changed to 0.8 and the order with respect to B_2D_6 changed to –1.2. The activation energy was found to be 14 ± 1 kcal/mole. A mechanism is proposed involving the thermal dissociation of both $Al(BH_4)_3$ and B_2D_6 followed by a rate-determining collision of B_2D_6 with borane radicals. The changing orders of reaction are consistent with a derived steady-state expression for the exchange. Direct experimental evidence was obtained to prove that the boron atoms are undergoing exchange in the reaction by the use of B^{10} enriched B_2D_6. (auth)

39043 THE KINETICS OF THE OXIDATION OF IRON(II) AND ITS SUBSTITUTED tris-(1,10-PHENANTHROLINE) COMPLEXES BY CERIUM(IV). G. Dulz and N. Sutin (Brookhaven National Lab., Upton, N. Y.). Inorg. Chem., 2: 917-21(Oct. 1963). (BNL-6805)

The kinetics of the oxidation of iron(II) and a number of its substituted tris-(1,10-phenanthroline) complexes by cerium(IV) were investigated in sulfuric acid using a rapid-mixing and flow technique. The free energies of activation for the latter reactions were found to be related to their standard free energy changes. The rate constant for the oxidation of tris-(1,10-phenanthroline)-iron(II) by cerium(IV) increased with increasing sulfuric acid concentration. The second-order rate constant for the $Fe(phen)_3^{2+}$–Ce(IV) reaction in 0.50 F H_2SO_4 is 1.42×10^5 F^{-1} sec^{-1} at 25.0°C with an activation energy of 6.5 kcal $mole^{-1}$. The corresponding quantities for the Fe(II)–Ce(IV) reactions are 1.3×10^6 F^{-1} sec^{-1} and 9.5 kcal $mole^{-1}$, respectively. The results are discussed in terms of the Marcus theory of electron-transfer reactions. (auth)

39044 THE REACTION OF RARE EARTH OXIDES WITH A HIGH TEMPERATURE FORM OF RHODIUM(III) OXIDE. Aaron Wold, Ronald J. Arnott, and William J. Croft (Massachusetts Inst. of Tech., Lexington and Sperry Rand Research Center, Sudbury, Mass.). Inorg. Chem., 2: 972-4(Oct. 1963).

Lanthanum rhodium oxide and neodymium rhodium oxide, containing rhodium in the trivalent state, were prepared and found to possess distorted perovskite structures. They are orthorhombic and probably belong to space group D_{2h}^{16} Pbnm. The lattice constants are a = 5.524, b = 5.679, c = 7.900 Å for $LaRhO_3$ and a = 5.402, b = 5.772, c = 7.816 Å for $NdRhO_3$. The distinguishing feature of the distortion is that $a < c/\sqrt{2} < b$, indicating that it is probably due to a size effect only. This is in contrast to the distortion observed for $LaMnO_3$ ($c/\sqrt{2} < a < b$) that is caused by both an electronic ordering (Jahn-Teller) and size effects. Neither samarium oxide nor yttrium oxide form a simple perovskite when allowed to react with rhodium(III) oxide under the same conditions used to prepare neodymium rhodium oxide.

This implies that the maximum distortion possible due to size effects is of the type where $a < c/\sqrt{2} < b$ and can be distinguished from the distortion caused by electron ordering. The existence of two forms of rhodium oxide, a hexagonal low temperature form with the corundum structure and a high temperature form apparently related to the perovskites, is also reported. The low temperature form transforms to the high temperature form above 750°. (auth)

39045 PHASE EQUILIBRIA IN THE SYSTEM SODIUM FLUORIDE–YTTRIUM FLUORIDE. R. E. Thoma, G. M. Hebert, H. Insley, and C. F. Weaver (Oak Ridge National Lab., Tenn.). Inorg. Chem., 2: 1005-12(Oct. 1963).

A phase diagram of the condensed system $NaF-YF_3$ was constructed from data obtained in cooling-curve and quenching experiments. The number and identity of phases coexisting at equilibrium were determined by use of the x-ray diffractometer and the petrographic microscope. Two compounds, $NaF \cdot YF_3$ and $5NaF \cdot 9YF_3$, were formed from the components. Each compound exists in two polymorphic forms, the high-temperature form in both cases crystallizing from molten mixtures as fluorite-like cubic crystals. The two cubic phases form a continuous solid solution with a maximum melting temperature of 975°C at the composition $5NaF \cdot 9YF_3$. Lattice parameters and refractive indices of the solid solution appear to be linear functions of the YF_3 content, a = 5.447–5.530 Å, refractive index 1.430–1.470. Pure crystals of $NaF \cdot YF_3$ invert from the fluorite cubic form, on cooling below 691°C, to a hexagonal form that is isostructural with β_2-Na_2ThF_6, with lattice constants a = 5.95, c = 3.52 Å. The five primary phase fields below the liquidus were found to be NaF, hexagonal $NaF \cdot YF_3$, $NaF \cdot YF_3$–$5NaF \cdot 9YF_3$ ss, and two forms of YF_3. Two eutectics occur in association with these primary phases, at 29 and 75 mole % YF_3 and at 638 and 947°C, respectively. Because of the isomorphism of YF_3 with the trifluorides of the rare earths samarium–lutetium and the similarity of their cation sizes, the system $NaF-YF_3$ is predicted to be an approximate model for each of the binary systems SmF_3-LuF_3 with NaF. (auth)

39046 MAGNETIC AND ELECTRIC PROPERTIES OF MONOSULFIDES AND MONONITRIDES OF THORIUM AND URANIUM. R. Didchenko and F. P. Gortsema (Union Carbide Corp., Parma, Ohio). Inorg. Chem., 2: 1079-80(Oct. 1963).

Studies on the monosulfides and nitrides of U and Th revealed that US is ferromagnetic with a Curie point at 180°K and a molar susceptibility of 6280×10^{-6} emu at 298°K ($\mu^B = 2.46$), while ThS and ThN are diamagnetic. The phase $UN_{1.33}$ (U_3N_4) was found to be antiferromagnetic with a Weiss constant $\theta = -262$, but the phases with lower nitrogen content behave in a manner characteristic of ferrimagnetic materials. The ferrimagnetic behavior of lower nitrides may be best explained by the presence of a sublattice of U^{3+}, which would tend to form and grow as the nitrogen content is decreased. The monosulfide and mononitride of Th are electronic conductors with a low specific resistivity ($\sim 10^{-4}$ ohm-cm) and a Seebeck coefficient of a few μvolts per degree at room temperature. Between room temperature and 1300°K the resistivity for the uranium compounds increases very slightly: from 0.9 to 1.4×10^{-4} ohm-cm for UN and from 3.6 to 4.3×10^{-4} ohm-cm for US. (P.C.H.)

39047 FORMATION OF NEGATIVE IONS IN $SbCl_3$. Victor E. Grob (United Aircraft Corp., East Hartford, Conn.). J. Chem. Phys., 39: 972-8(Aug. 15, 1963).

The formation of negative ions in $SbCl_3$ by low-energy electrons was investigated using a modification of a total ionization tube that allows the ion species to be determined and prevents contact potentials from affecting the electron energy in the collision region. The identification of the specific reaction taking place was obtained by modifying the total ionization tube to operate as a magnetron beyond cutoff. The mass of the ion species was then determined from an analysis of the ion current to the collector as a function of the applied axial magnetic field and the ion collector bias. The electron-energy distribution had an effective width at half-height of approximately 0.07 ev, which was obtained using the retarding potential difference method. With the apparatus the most probable initial ion reaction was $SbCl_3 + e \rightarrow SbCl_2 + Cl^-$. The value of the dissociative capture cross section at the point of ion appearance was $(1.8 \pm 0.3) \times 10^{-18}$ cm^2, and the minimum energy of the electron for the appearance of ions was approximately 0.01 ev at a gas temperature range 25–50°C. The dissociation energy for the reaction $SbCl_3 \rightarrow SbCl_2 + Cl$ was 3.69 ± 0.15 ev. (auth)

39048 VIBRATIONAL ENERGY LEVELS FOR AN SCF WAVEFUNCTION OF THE HYDROGEN MOLECULE. Gerald M. Leies (Georgetown Univ., Washington, D. C.). J. Chem. Phys., 39: 1137-8(Aug. 15, 1963).

The correlation energy constant of the hydrogen molecule, which is different from the exact energy, was determined by comparing the vibrational energy level differences ΔG determined from SCF functions with experimentally determined ΔG values. The comparison was made for H_2 (ground state) because it is a relatively simple molecule and because SCF energies were available for a wide range of internuclear distances (0.4-3.2 au). Vibrational spectroscopic constants for H_2 are tabulated. (P.C.H.)

39049 LATTICE VIBRATIONS AND SPECIFIC HEATS OF SEVERAL RARE-EARTH ETHYLSULFATES. Eugene Y. Wong (Univ. of California, Los Angeles) and Edward H. Erath. J. Chem. Phys., 39: 1629-32(Oct. 1, 1963).

The vibronic absorption spectra of praseodymium, neodymium, and erbium ethyl sulfates, were used to construct tentative vibrational energy-level diagrams for the crystals. With this technique, 42 levels ranging from 18 to 360 cm^{-1} were identified. The energy-level spectra were used to calculate the specific heat of the crystals from 0 to 15°K as an additional check on the origin of the observed absorption spectra and fair to good agreement with measured specific heats was achieved. (auth)

39050 ENERGY OF THE LITHIUM ATOM BY THE LEAST-SQUARES LOCAL ENERGY METHOD. B. M. Gimarc and A. A. Frost (Northwestern Univ., Evanston, Ill.). J. Chem. Phys., 39: 1698-1702(Oct. 1, 1963).

The least-squares local energy method was applied to the lithium atom ground state. For a correlated wavefunction of 51 terms the calculated energy was −7.4653 hartrees compared with the exact nonrelativistic value of −7.4781 hartrees. Important limitations of the method are discussed and possibilities for avoiding them are proposed. (auth)

39051 ANTIFERROMAGNETISM OF $UO_2 \cdot 2H_2O$. Titus Pankey, Frank E. Senftle, and Frank Cuttitta (Geological Survey, Washington, D. C.). J. Chem. Phys., 39: 1702-6 (Oct. 1, 1963).

Magnetic susceptibility measurements were made on $UO_2 \cdot xH_2O$ for x = 1.78 to x = 2.13, and from 77 to 375°K. As the value of x decreased the susceptibility increased. Both these data and structural arguments imply that the formula of this compound is $U(OH)_4$ rather than the dihydrate form. Based on this concept the data were corrected for diamagnetism and also small amounts of UO_2

and H_2O which were present. The molar susceptibility of U^{4+} in $U(OH)_4$ is nearly an order of magnitude less than in other uranium compounds, and it is suggested that this is probably due to superexchange between adjacent uranium atoms through intervening oxygen atoms. (auth)

39052 SPO (SPLIT-p-ORBITAL) METHOD. IV. CALCULATIONS FOR THE $(2p)^2$ STATE OF HELIUM. Michael J. S. Dewar and Alice L. H. Chung (Univ. of Chicago). J. Chem. Phys., 39: 1741-7(Oct. 1, 1963).

The energies of the three possible $(2p)^2$ states of helium (^1S, ^1D, ^3P) were calculated with SPO functions and with correlated Hylleraas functions. Calculations were also carried out for the nonstationary $(2p_z)^2$ state. The results indicate that vertical correlation is an important factor in systems containing p electrons. (auth)

39053 RATE OF EXCHANGE OF HALIDE NUCLEI WITH MERCURY(II) IN AQUEOUS SOLUTION. D. E. O'Reilly, G. E. Schacher, and K. Schug (Argonne National Lab., Ill.). J. Chem. Phys., 39: 1756-68(Oct. 1, 1963).

Linewidths ΔH_{ms} of the I^{127} nuclear magnetic resonance of water solutions of KI in the presence of varying amounts of Hg^{II} were measured at temperatures in the range 273 to 373°K. At constant $[I^-]$, ΔH_{ms} depended linearly on the concentration of Hg^{II}: $\Delta H_{ms} = k_{ms}[Hg^{II}]$, where k_{ms} ranges from 1.9×10^3 G $\underline{M}^{-1}$ at $[I^-] = 4.0\underline{M}$ to 3.7×10^5 G $\underline{M}^{-1}$ at $[I^-] = 0.005\underline{M}$ (300°K). By means of the modified Bloch equations the results may be interpreted as due to a rapid exchange of iodine, nuclei among the species I^-, HgI_4^{2-}, and $HgI_3(OH_2)^-$. Broadening of the I^{127} nuclear magnetic resonance is produced by relatively short relaxation times of I^{127} in the mercury complexes; $T_2(I^-) = 1.7 \times 10^{-4}$ sec, $T_2(HgI_4^{2-}) = 1.1 \times 10^{-7}$ sec (300°K). Bimolecular rate constants for the following exchange reactions were obtained: $HgI_4^{2-} + I^- \rightarrow I^- + HgI_4^{2-}$ (k_1), $HgI_3(OH_2)^- + I^- \rightarrow I^- + HgI_3(OH_2)^-$ (k_2), and $HgI_3(OH_2)^- + I^- \rightarrow H_2O + HgI_4^{2-}$ (k_3). At 300°K, $k_1 = 8.8 \times 10^7 \underline{M}^{-1}$ sec^{-1}, $k_2 = 5.7 \times 10^9 \underline{M}^{-1}$ sec^{-1}, and $k_3 = 7.1 \times 10^8 \underline{M}^{-1}$ sec^{-1}, $\Delta E_1^{\ddagger} = 1.8 \pm 0.6$ kcal mole^{-1}. The rates appeared to be diffusion limited and may be interpreted by an appropriate solution of the Smoluchowski diffusion equation. Similar but less extensive measurements were made on KBr solutions containing added $HgBr_2$. Again exchange appeared to be diffusion controlled and $T_2(HgBr_4^{2-})$ was much shorter than $T_2(Br^-)$. The relatively small value of k_1 is attributed to a negative entropy of activation associated with dielectric polarization of the solvent by the ions involved. The observed relaxation rate of I^{127} in HgI_4^{2-} combined with an estimate of the quadrupolar coupling constant of I^{127} in solid K_2HgI_4 allows an estimation of the rotational correlation time τ_c of HgI_4^{2-} in solution, which at 25°C is equal to 1.4×10^{-11} sec. This time is a factor of six shorter than estimated from the Debye expression for τ_c. (auth)

39054 LATTICE VIBRATIONS OF $LaCl_3$ AND $LaBr_3$ FROM VIBRONIC SPECTRA. Isaac Richman, Robert A. Satten, and Eugene Y. Wong (Univ. of California, Los Angeles). J. Chem. Phys., 39: 1833-46(Oct. 1, 1963).

The polarized vibronic spectra of $PrCl_3$ and $PrBr_3$, as well as Pr^{3+} in $LaCl_3$ and $LaBr_3$, were observed. The theory of vibronic transitions for the dilute salt is shown to predict a spectrum which closely resembles the vibronic spectrum of the pure salt, in agreement with experiment. Approximations valid when the optical vibrational branches of the crystal are flat leading to k = 0 selection rules are shown to lead to agreement with the spectra fairly well, although slight violations in selection rules occur and can readily be explained. Tentative identifications of crystalline modes of vibration are assigned partly with the help of polarization data and vibronic selection rules, partly by consideration of frequency shift in comparing the chloride and bromide vibronic spectra, partly from Raman scattering data, and partly with the aid of the far-infrared absorption data of Buchanan, Murphy, and Caspers. The vibronic data in turn help refine the interpretation of the far-infrared results. The difference between longitudinal and transverse vibrating frequencies is discussed. (auth)

39055 TESTING OF DIATOMIC POTENTIAL-ENERGY FUNCTIONS BY NUMERICAL METHODS. J. K. Cashion (Univ. of California, Livermore). J. Chem. Phys., 39: 1872-7(Oct. 1, 1963).

An accurate and efficient numerical method of solving the radial Schrödinger equation for a diatomic molecule was employed in two tests relating to approximate potential functions. First, quantitative estimates were made of the errors in the approximate eigenvalue equation derived by Pekeris for the rotating Morse oscillator. Secondly, as an example of testing a potential function for which no analytic solution is known, the eigenvalues of the Clinton potential were compared with those of the Morse and with experiment. (auth)

39056 ATOM-MOLECULE REACTION OF HYDROGEN STUDIES BY MOLECULAR BEAMS. Sheldon Datz and Ellison H. Taylor (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 39: 1896-7(Oct. 1, 1963).

The reaction $D + H_2 \rightarrow HD + H$ was studied with crossed molecular beams. The angular distribution was interpreted in terms of a specific collision model by using a calculated centroid distribution as reference. Results were consistent with a linear complex of short life yielding largely unexcited products. (M.C.G.)

39057 SOME STUDIES OF RELAXATION PROCESSES IN Tb^{3+} USING PULSED EXCITATION. G. E. Peterson and P. M. Bridenbaugh (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Opt. Soc. Am., 53: 1129-38(Oct. 1963).

The relaxation paths of Tb^{3+} in two hosts, $SrMoO_4$ and $Na_{0.5}Eu_{0.5}WO_4$, were studied using pulsed and continuous illumination. In the molybdate structure resonance coupling between the host lattice and the rare earths was found to strongly influence the energy levels excited. The doping of $Na_{0.5}Eu_{0.5}WO_4$ with Tb results in a rare-earth-ion–rare-earth-ion resonance-coupled system in which the Eu may be excited by pumping the Tb. (auth)

39058 CRYSTAL STRUCTURE OF NIOBIUM DIOXIDE. Nobuzo Terao (Union Carbide European Research Associates, Brussels). Japan. J. Appl. Phys., 2: 565-73(Sept. 1963). (In French)

The x-ray-diffraction results on NbO_2, prepared by heating in vacuo a mixture of powders of Nb_2O_5 and Nb, confirm the previous electron-diffraction results obtained with thin films. Besides the strong reflections attributed to a rutile lattice structure, a great number of additional weak reflections were observed. Following this observation, the structure analysis was undertaken by calculating the structure factors on various models. Three types of possible structures derived from the rutile structure were investigated; a superlattice, a defective lattice, and an interstitial lattice structure, respectively. It is concluded that there is only one possible structure modification of a superlattice type. Some of the O–Nb–O molecules in the rutile structure change their molecular orientation on the (001) planes whose stacking sequence is expressed by $\alpha\beta\alpha'\beta\alpha \ldots$ (auth)

39059 ELECTRICAL CONDUCTIVITY OF AMMONIUM PERCHLORATE. Philip Zirkind and Eli S. Freeman (Picatinny Arsenal, Dover, N. J.). Nature, 199: 1280-1(Sept. 28, 1963).

An investigation was made of the electric conductivity of ammonium perchlorate (solid) as a function of temperature and gaseous atmosphere. The conductivity measurements were made over the temperature range of 25 to 125°C under vacuum and in oxygen and argon. Results are presented in graph form with conductivity decreasing linearly with $(1/T) \times 10^3$ °K^{-1}. Argon and oxygen depressed the electric conductivity approximately one and two orders of magnitude, respectively. (M.C.G.)

39060 EFFECT OF ELECTRON DONORS ON THE ISOTOPIC EXCHANGE BETWEEN ALUMINIUM(III), GALLIUM(III) AND INDIUM(III) IODIDES AND ALKYL IODIDES. A. Polaczek (Univ. of Warsaw) and A. Halpern. Nature, 199: 1286-7(Sept. 28, 1963).

The isotopic exchange reactions of iodine between aluminum, gallium, and indium triiodides and methyl, ethyl, and propyl iodides were studied. The metal iodides were labeled with I^{131}. The fastest exchange was in the $AlI_3^{131}-CH_3I$ solution in which equilibrium was reached within less than one minute, while the slowest exchange was in the $InI_3^{131}-C_3H_7I$ solution where the fraction of exchange at the end of the first minute was equal to 0.11. The addition of small amounts of an electron donor substance to the alkyl iodide caused strong exchange blocking. The fraction of the radioiodine atoms that did not participate in the exchange when the electron donor was present in the solution increased regularly with the value of the molar ratio of electron donor to metal iodide. (M.C.G.)

39061 ELECTRON PARAMAGNETIC RESONANCE IN NON-IRRADIATED BONE. Robert O. Becker (Veterans Administration Hospital, Syracuse, N. Y.). Nature, 199: 1304-5(Sept. 28, 1963).

Electron paramagnetic resonance signals were obtained from cortical bone samples about 0.5 by 3 mm from human tibia and bullfrog tibia. Samples were mounted on quartz filaments and suspended in quartz tubes so that the angular relationship between the long axis of the bone sample and the main magnetic field could be altered. Resonance signals with g values dependent on the angular relationship were observed in all samples of bone from each species. In amphibian bone, a large well-defined resonance about 200 gauss wide was noted in the vicinity of g = 2.3. In the 90° position a well-defined almost symmetrical resonance appeared at g = 2.0 that was much more anisotropic, appearing to merge with the g = 2.3 peak in the 0° position. In human bone a similar well-defined resonance was found in the g = 2.3 vicinity, being more prominent in the 0 and 90° orientation than in the 45°. A very broad resonance signal appeared, reaching a peak at approximately g = 1.8. (M.C.G.)

39062 ISOMER SHIFT OF Fe^{57} IN InAs. George Bemski and João Carlos Fernandes (Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro). Phys. Letters, 6: 10-11(Aug. 15, 1963). (In English)

Co^{57} was diffused in InAs crystals and the resulting Mössbauer spectra of the daughter nuclei Fe^{57} were measured. The spectra consisted of a doublet with an isomer shift of 0.051 ± 0.004 cm/sec with respect to stainless steel absorbers. The quadrupole splitting was 0.045 cm/sec. The observed shift was consistent with that due to Fe in $3d^5$ configuration. It was suggested that such a configuration corresponds to a substitutional Fe^- ion. Several possibilities for the lack of isomer shift between n and p-type InAs were proposed. (C.E.S.)

39063 THE CUBIC FIELD SPLITTING OF THE Eu^{++} EPR SPECTRUM IN THE ALKALINE EARTH FLUORIDES. R. S. Title (International Business Machines Corp., Yorktown Heights, N. Y.). Phys. Letters, 6: 13-14(Aug. 15, 1963). (In English)

Electron paramagnetic resonance data are reported for Eu^{2+} in SrF_2, BaF_2, and CaF_2. To check the dependence of the spin hamiltonian parameter on the crystalline field potential the log of the spin hamiltonian parameter is plotted against the log of the separation of the Eu^{2+} ion from the neighboring F ions on a point charge model. A similar plot was performed for Gd^{3+} ions. The splitting of the Eu^{2+} spectrum in the alkaline earth fluoride lattices shows an agreement with a linear dependence of the crystalline field potential. The results obtained for Gd^{3+} in these lattices indicate a pulling in of the charges on neighboring fluorine ions. (C.E.S.)

39064 STUDY OF DIFFUSION IN GLYCEROL BY THE MÖSSBAUER EFFECT OF Fe^{57}. D. St. P. Bunbury, J. A. Elliott, H. E. Hall, and J. M. Williams (Univ. of Manchester, Eng.). Phys. Letters, 6: 34-6(Aug. 15, 1963). (In English)

The resonance absorption of 14.4-kev γ rays of Fe^{57} was observed in solutions of ferric sulfate in glycerol over the temperature range −100 to +10°C. The resonance absorption line becomes steadily broader as the temperature is raised, but is still essentially recoilless when the sample is liquid in the vicinity of 0°C. The observed line broadening is related to the motion of Fe^{57} atoms in the solution. The mean square displacements of the Fe^{2+} and Fe^{3+} ions as a function of time were presented. It is concluded that a considerable part of the diffusion proceeds by a jump mechanism. (C.E.S.)

39065 SPIN WAVE SCATTERING OF POLARIZED NEUTRONS. E. J. Samuelsen, T. Riste, and O. Steinsvoll (Institutt for Atomenergi, Kjeller, Norway). Phys. Letters, 6: 47-8(Aug. 15, 1963). (In English)

Spin wave investigations near the (111) reflection of magnetite were performed by means of a monochromatic polarized neutron beam. Results confirm the theoretical predictions of polarization dependence of spin wave scattering of neutrons. (C.E.S.)

39066 FERRO- AND METAMAGNETISM OF RARE EARTH COMPOUNDS. G. Busch (Eidgenössische Technische Hochschule, Zurich), P. Junod, O. Vogt, and F. Hulliger. Phys. Letters, 6: 79-80(Aug. 15, 1963). (In English)

The magnetic properties of the phosphides, nitrides, antimonides, and arsenides of Gd, Tb, Dy, Ho, and Er were investigated. Lattice parameters, molar paramagnetic susceptibility, magnetic moments, and critical temperatures were measured. It is shown that some of the compounds are ferromagnetic and others are metamagnetic. (C.E.S.)

39067 NUCLEAR MAGNETIC RELAXATION IN LiF AT HIGH TEMPERATURES. Maurice Eisenstadt (Columbia Univ., New York). Phys. Rev., 132: 630-5(Oct. 15, 1963).

Measurements of T_1 and T_2, the spin-lattice and spin-spin relaxation times, are reported for Li^7 and F^{19} nuclei in a single crystal of LiF. T_1(Li) was measured from room temperature to the melting point (1120°K) and the other quantities from 830°K to the melting point. Above 620°K, relaxation is caused exclusively by the diffusion of Li and F ions. T_1(Li), T_2(Li), and T_1(F) are mainly determined by ν_{Li}, the jump frequency of Li ions, and T_2(F) mainly by ν_F. Using a theory of relaxation developed elsewhere, ν_{Li} and ν_F are obtained for the region of intrinsic diffusion as $\nu_{Li} = 1.7 \times 10^{16} \exp(-1.81 \text{ eV/kT})$ and $\nu_F = 4.5 \times 10^{17} \exp(-2.2 \text{ ev/kT})$. For the extrinsic region, the motional activation energy of Li ions is obtained as 0.71

ev. The values of ν_{Li} are in good agreement with those obtained from conductivity measurements. Below 620°K quadrupolar relaxation due to lattice vibrations and relaxation by paramagnetic impurities become important, and rough values are obtained for these contributions to T_1(Li). Large angular variations of T_1 and T_2 are observed in the region of relaxation due to atomic diffusion. T_2(Li) and T_1(Li) vary by a factor of 2 and 1.5, respectively, as a function of crystal orientation, in good agreement with theoretical prediction. A crude measurement of T_1(Li) in molten LiF is discussed. (auth)

39068 ELECTRIC QUADRUPOLE INTERACTIONS IN RARE-EARTH IONS. A. J. Freeman (Massachusetts Inst. of Tech., Cambridge and U. S. Army Materials Research Agency, Watertown, Mass.) and R. E. Watson. Phys. Rev., 132: 706-9(Oct. 15, 1963).

Electric quadrupole interactions in rare-earth ions arising from electric field gradients due to valence electrons (q_{4f}) and/or crystal fields external to the ion (q_{lat}) are discussed. The contribution of the Sternheimer antishielding factors to both q_{4f} and q_{lat} are calculated for the Ce^{3+} ion using the method based on the unrestricted Hartree-Fock formalism. The ionic antishielding factor (γ_∞) is −73.5, and it is found that the total ionic contribution to the electric field gradient can be comparable in magnitude (and may be opposite in sign) with the valence electron contribution (augmented by the internal antishielding factor). The possible relation of these results to the temperature dependence of measured electric quadrupole interactions is noted. (auth)

39069 THE INFLUENCE OF SHIFTING ON THE INTENSITY OF A MAGNETIC NUCLEAR RESONANCE SIGNAL. O. Kanert and E. Kappler. Phys. Status Solidi, 3: K326-31(1963). (In German)

The influence of shifting on the integral intensity of nuclear magnetic resonance signals from alkali halide crystals was investigated. By means of the quadrupole exchange effect a displacement of the magnetic energy levels of nuclear spin appeared. Methods of calculation are described and results are given. (M.C.G.)

39070 A NEW METHOD FOR DETERMINING THE TEMPERATURE OF CERTAIN SPECTRAL SOURCES. Rev. Phys., Acad. Rep. Populaire Roumaine, 8: 21-35 (1963). (In Russian)

Determination of the temperature of spectral sources presents many difficulties; the currently used methods, such as the inversion of the spectral lines, distribution of the intensity component of the molecular band, or the intensity ratios of the lines, are often unsatisfactory. The dependence of the intensity of the spectral resonance lines of the alkali metals on the temperature of the source was previously investigated. The source was assumed to be in a thermodynamic equilibrium. On the basis of the results obtained in that study, a method was developed for the purpose of determining exactly the temperature of hot sources. Air−methane, air−acetylene, and oxygen−methane flame techniques were examined, in an attempt to determine the temperature dependence of the moment in which the mass ionization of the atoms of the sample occurs. The temperatures considered ranged from 2170 to 2590°C; the use of the alkali metal chlorides NaCl, KCl, and CsCl made it possible to cover this relatively wide range of temperature. Concentrations of 4.063×10^{-5} mole/cm^3 were used in all cases; in addition, a concentration of 1.04×10^{-4} mole/cm^3 was used for CsCl alone. The useful range may be extended downward by means of atomic absorption techniques. The findings of the previous work were confirmed in this study. (TTT)

39071 ION-EXCHANGE REACTIONS OF CESIUM. N. T. Coleman (Univ. of California, Riverside), Doris Craig, and R. J. Lewis. Soil Sci. Soc. Am. Proc., 27: 287-9(May-June 1963).

Column leaching experiments with 0.001N CsCl 1N KCl, or $CaCl_2$ showed Cs sorption by a number of clays to be much larger from Ca than from K solutions. The sorption affinity of Cs relative to the complementary ion corresponded with that found by others for the Cs-K ion pair, but in Cs-Ca systems the Cs was sorbed to a larger extent than would have been expected from the results of experiments where Cs-Ca ratios in the equilibrium solution were not so small. While all except a very small proportion of the sorbed Cs was displaced on leaching with 1N KCl, some 36 times as much remained after leaching with equal volumes of 1N $CaCl_2$. Vermiculite sorbed very large amounts of Cs (about ⅓ of exchange capacity) from 0.001N CsCl-1N $CaCl_2$. The sorbed Cs was largely fixed against exchange with 1N $CaCl_2$. This suggests that Cs contained in interlayer spaces of vermiculite results in interplanar distances that will admit K but not Ca. (auth)

39072 SORPTION OF CESIUM BY SOILS AND ITS DISPLACEMENT BY SALT SOLUTIONS. N. T. Coleman (Univ. of California, Riverside), R. J. Lewis, and Doris Craig. Soil Sci. Soc. Am. Proc., 27: 290-4(May-June 1963).

Cesium was sorbed by montmorillonite, illite, and kaolinite in quantities corresponding to exchange saturation and was displaced readily on leaching with 1N KCl or $CaCl_2$. Vermiculite and heated (600°C, 12 hr) K-montmorillonite bound Cs tightly against displacement by $CaCl_2$ and $AlCl_3$, but not by KCl or NH_4Cl. Prolonged leaching with 1N KCl removed 97.5% of the Cs sorbed by heated K-montmorillonite, while 1N $CaCl_2$ eventually displaced 88%. Potassium and Rb sorbed on vermiculite were displaced more rapidly by Ca or Mg than by monovalent ions, but this was not the case with heated K-montmorillonite. The exchange-displacement behavior of Cs on vermiculite and heated K-montmorillonite suggests that the ion is unique in that its sorption in interlayer spaces leads to interplanar distances that admit K and NH_4 ions but greatly restrict the entry of Ca. Cesium, then, is not expected to follow the fixation-release rules that have been developed for K and NH_4. Heated montmorillonite samples leached with mixtures of CsCl and other salts sorbed more Cs when the complementary ion was Ca or Al than when it was K or NH_4. Differences were especially pronounced at low equivalent fractions of Cs in the leaching solution, showing a larger preference by exchange sites for Cs over divalent than over monovalent ions. Apparent specific sorption of Cs against exchange with $CaCl_2$ occurred at quite large Cs saturations. (auth)

39073 RADIOMETRIC STUDY ON THE SUITABILITY OF CINCHONIN AS PRECIPITATION REAGENT FOR TUNGSTEN AND MOLYBDENUM. E. Merz (Kernforschungsanlage, Julich, Ger.). Z. Anal. Chem., 191: 416-29(1962). (Jul-93-RC). (In German)

The precipitation of W and Mo with cinchonin was studied using P^{32}, Mo^{99}, and W^{185}. The effects of the acid, acid concentration, solution volume, and precipitation time on the quantitative precipitation of the metals were determined. W was precipitated only from HCl and HNO_3, and no quantitative precipitation of Mo was obtained. No variation was found in the completeness of the precipitation

using HCl concentrations of 1 to 6N, but precipitation is prevented or strongly inhibited in very strong solutions. The quantitative precipitation of W is very strongly dependent on the solution volume, but there is no sharp time dependence. A study of the effectiveness of cinchonin and tannin as combined precipitation agents showed no advantage over the use of cinchonin alone, except in the removal of interferring elements in the precipitation. (J.S.R.)

39074 CONDUCTOMETRIC DETERMINATION OF THE DIFFUSION COEFFICIENTS OF PERTECHNETATE IONS IN AQUEOUS SOLUTIONS. K. Schwochau and L. Astheimer (Kernforschungsanlage, Julich, Ger. and Universität, Cologne). Z. Naturforsch., 17a: 820(1962). (Jul-92-RC). (In German)

The conductivity of diluted aqueous solutions of potassium pertechnetate was determined at 25.0 ± 0.1°C. The molar conductivities found are tabulated. By graphic extrapolation the molar conductivity of $KTcO_4$ at 25° and infinite dilution was 129.0 ± 0.5 $\Omega^{-1}cm^2mol^{-1}$. From the known equivalent conductivity of K^+, the equivalent conductivity of TcO_4^- at 25° and infinite dilution was calculated to be (55.5 ± 0.5) $\Omega^{-1}cm^2val^{-1}$. The diffusion coefficient was then calculated as (1.48 ± 0.01) 10^{-5} cm^2sec^{-1}. (J.S.R.)

39075 THE STABILIZATION OF HO_2 AND DO_2 BY INERT MOLECULES. J. W. Linnett and N. J. Selley (Oxford Univ.). Z. Physik. Chem. (Frankfurt), 37: 402-13 (June 1963). (In English)

The effects of argon, nitrogen, carbon dioxide, carbon tetrafluoride, and sulfur hexafluoride on the second explosion limits of hydrogen + oxygen and deuterium + oxygen mixtures at 530°C were studied. The relative efficiencies of the different molecules in stabilizing excited HO_2 and DO_2 were calculated and are discussed. It was concluded that no single effect can account for all the results, but that some of the observations can be explained by supposing that, in some collisions, vibration-vibration energy transfers are important. (auth)

39076 INTERDIFFUSION COEFFICIENTS OF CERTAIN GASES MEASURED BY OPTICAL METHODS. B. A. Ivakin and P. E. Suetin (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Tekhn. Fiz., 33: 1007-10(Aug. 1963). (In Russian)

An installation and method for measuring coefficients of gas interdiffusion are described. Experimental results for 22 gases, measured at 760-mm Hg pressure and 273°K, were tabulated and showed good agreement with data obtained previously by other methods. (R.V.J.)

39077 THE CONSTITUTION OF PERURANIC ACID AND THE URANIUM VI OXIDE HYDRATES. Frank Dalton Lonadier. Thesis, Austin, Tex., Univ. of Texas. 1959. 71p.

The isotopic exchange of oxygen-18-enriched water with peruranic acid and the uranium(VI) oxide hydrates was studied. No attempt was made to record kinetic data on the exchange reaction. The problem dealt with the interpretation of the equilibrium exchange data and using it to postulate structures for the compounds. A weighed sample of $UO_4 \cdot 2H_2O$ was exchanged with a known volume of oxygen-enriched water. After an exchange time of from a few days to several months the water was removed by vacuum distillation, electrolyzed, and the oxygen-18 content determined with the aid of a mass spectrometer. The number of exchangeable oxygens per atom of uranium was calculated from these data. Peruranic acid exhibited three exchangeable oxygen atoms per atom of uranium. The number of exchangeable oxygen atoms did not increase with an increase in time from a few days to several months. This exchange was compatible with a constitution of $UO(OH)_3OOH$ for peruranic acid but not for another constitution that was reported in the literature. A study of the labeled oxygen through subsequent stepwise decomposition reactions from $UO_4 \cdot 2H_2O$ to U_2O_7, from U_2O_7 to UO_3 and from UO_3 to U_3O_8 verified the proposed constitution. The first thermal decomposition product of peruranic acid, the anhydrous peroxide U_2O_7, reacts spontaneously with water liberating a non-exchangeable oxygen atom that arises from the cleavage of the peroxide linkage. The reaction product of U_2O_7 with water at room temperature is $\alpha UO_3 \cdot 2H_2O$. At 100°C the product is the β modification of $UO_3 \cdot 2H_2O$. The two crystal modifications of the dihydrate of uranium(VI) oxide as well as the three crystal modifications of the monohydrate of uranium(VI) oxide were prepared and exchanged in the same manner as peruranic acid. The exchange rate was very much slower than peruranic acid. The results of the exchange experiments showed the two crystal modifications of the dihydrate to be different compounds. The α modification showed four exchangeable oxygen atoms per atom of uranium leading to a constitution of $UO(OH)_4$. The β modification exhibited three exchangeable oxygen atoms per atom of uranium. The constitution of the β modification is $UO_2(OH)_2 \cdot H_2O$. Since the x-ray powder pattern is identical with that of the β monohydrate the water molecule could be zeolytic. The monohydrates were exchanged with oxygen-18-enriched water at temperatures ranging from room temperature to 165°C. The α-crystal modification showed two exchangeable oxygen atoms per atom of uranium at 100°C. The β-crystal modification exhibited two exchangeable oxygen atoms at room temperature. The two mole exchange was verified by the oxygen-18 content in the decomposition products. These results indicated that both crystal forms have a constitution of $UO_2(OH)_2$. The γ modification exhibited only one exchangeable oxygen atom per atom of uranium at temperatures ranging from room temperature to 165°C. The γ modification is a different compound from either the α or β form, being a true hydrate with a constitution of $UO_3 \cdot H_2O$. (Dissertation Abstr., 24. No. 2, Aug. 1963)

39078 A RATIONAL EQUATION OF STATE FOR WATER AND WATER VAPOR IN THE CRITICAL REGION. E. S. Nowak (Univ. of Western Ontario, London). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-HT-35, 7p. (CONF-129-19)

From American Society of Mechanical Engineers, American Institute of Chemical Engineers 6th National Heat Transfer Conference and Exhibit, Boston, Aug. 1963.

A parametric equation of state was derived for water and water vapor in the critical region from experimental P-V-T data. It is valid in that part of the critical region encompassed by pressures from 3000 to 4000 psia, specific volumes from 0.0400 to 0.1100 ft^3/lb, and temperatures from 698 to 725°F. The equation of state satisfies all of the known conditions at the critical point. It also satisfies the conditions along certain of the boundaries, which probably separate supercritical liquid from supercritical vapor. The equation of state, though quite simple in form, is probably superior to any equation heretofore derived for water and water vapor in the critical region. Specifically, the deviations between the measured and computed values of pressure in the large majority of the cases were within three parts in one thousand. This coincides approximately with the overall uncertainty in P-V-T measurements. In view of these factors, it is recommended that the equation be used to derive values for such

thermodynamic properties as specific heat at constant pressure, enthalpy, and entropy in the critical region. (auth)

39079 VAPOR PRESSURE TABLES FOR WATER. O. C. Bridgeman and E. W. Aldrich (Phillips Petroleum Co., Bartlesville, Okla.). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-HT-30, 8p. (CONF-129-15)

From American Society of Mechanical Engineers, American Institute of Chemical Engineers 6yh National Heat Transfer Conference and Exhibit, Boston, Aug. 1963.

Data on vapor pressure of water in millimeters of Hg from 0 to 120°C at intervals of 0.1°C, vapor pressure of water in atmospheres from 0 to 374°C at intervals of 1°C, values of the thermodynamic temperature T in °K and of the derivative d in P/dT over the range from 0 to 374°C at intervals of 1°C, and transformation of temperatures and derivatives from the international practical scale to the thermodynamic scale over the range 0 to 450°C are tabulated. (P.C.H.)

39080 REFRACTOMETRIC AND POTENTIOMETRIC STUDIES OF THE URANYL PERCHLORATE–SODIUM CARBONATES SYSTEMS. STUDIES OF THE ELECTROCHEMICAL REDUCTION OF U/VI/ IN SODIUM CARBONATES SOLUTIONS ON THE MERCURIC CATHODE. Kohman Lucja and Perec Mieczyslaw (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). 70p. (CONF-207-3) (In Polish)

From second Yugoslavian Polish Symposium on Uranium Technology and Metallurgy, Zakopane, Poland, Sept. 1963.

Reactions that occur in the $UO_2/ClO_4/_2 - NaHCO_3$ and $UO_2/ClO_4/_2 - Na_2CO_3$ systems were investigated. Refractometric and potentiometric methods were employed, as well as chemical analyses of precipitates being in equilibrium with the solutions. The course of the reduction of U(VI) on a mercury cathode and the transition of U(VI) to UO_2aq. depending on solution compositions and temperature are explained. The polarographic method was used. (auth)

39081 A STUDY OF SOME URANIUM COMPOUNDS USED FOR PRODUCTION OF CERAMIC GRADE UO_2. Wojciech Dembinski, Andrzej Deptula, and Stanislaw Rykowski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). 23p. (CONF-207-10). (In Polish)

From Second Yugoslavian Polish Symposium on Uranium Technology and Metallurgy, Zakopane, Poland, Sept. 1963.

Potentiometric and analytical studies pointed out that polymerization of UO_2^{2+} ion to UO_2 $[(OH)_2\ UO_2]_4^{2+}$ is the first stage of the reaction between uranyl nitrate and ammonia. If ammonia is added slowly an easily filtrable ammonium uranate is formed with the hypothetical composition: $[(NH_4)_2\ O]_3 \times [UO_3 \cdot H_2O]_{20} \times 13H_2O$, which reacts further to form $[(NH_4)_2\ O]_3 \times [UO_3 \times H_2O]_{20} \times 7H_2O$. A rapid addition of ammonia leads to formation of a poorly filtrable precipitate with the composition: $[(NH_4)_2\ O]_{2.5} \times [UO_3 \times H_2O]_{20} \times 14H_2O$, which easily undergoes hydrolysis. The course of precipitation from uranyl nitrate solution containing urea upon addition of ammonia was also investigated using a potentiometric method. It was found, that a stoichiometric compound $H_2O \times UO_3 \times 2CO\ (NH_2)_2$ or urea ammonium polyuranates are formed, depending on the precipitation technique and urea concentration. The probable mechanism of the reaction in the investigated system is given. The homogenous precipitation method was used to obtaine urea uranates. X-ray-diffraction studies showed the urea uranate to crystallize in the orthorhombic system. The unit cell has the following dimensions: a = 7.33, b = 10.12, c = 12.10 Å, and the theoretic density equals 3.14 g/cm^3, containing four formula units as assumed. The observed pycnometric density was 3.10 g/cm^3. (auth)

Organic Chemistry

39082 (TID-19451) MASS TRANSFER IN IMMISCIBLE SYSTEMS. Final Report, September 16, 1959 to September 15, 1963. D. M. Himmelblau (Texas. Univ., Austin). Contract AT(40-1)-2458. 36p.

Work on the mass transfer of acetic acid in the water-methyl isobutyl ketone system demonstrated that the mass transfer coefficients (K) were not constant but depended on the concentrations in the system. K was defined by the standard Lewis equation $dC/dt = KA/V\ (C - C^*)$. Using the same equipment and with the aid of radioactive tracer techniques, the mass transfer rates and mass transfer coefficients were determined under nonsteady and nonequilibrium conditions with tracer transfer opposite to the main transfer. Concentrations measured as a function of time were fit to an appropriate equation using the "least squares" method. The mass transfer rates were calculated by material balance equations. The mass transfer coefficients were determined using the Lewis equation. The mass transfer rates and mass transfer coefficients were correlated with first and second order combinations of different independent variables such as the bulk and/or equilibrium concentrations, and with the transfer rate. No simple relationship was found between K and selected concentration parameters. No simple model could be found which was more effective than the Lewis model in the sense that it could predict the values of N with less error. On the other hand, many other models were found to be equally effective. (auth)

39083 DEUTERIUM-EXCHANGE REACTIONS WITH SUBSTITUTED AROMATICS. IV. THE POISONING EFFECT OF MOLECULES CONTAINING NITROGEN, SULPHUR, OR ARSENIC. R. A. Ashby and J. L. Garnett. Australian J. Chem., 16: 549-56(Aug. 1963).

The catalytic exchange properties of a number of organic compounds containing nitrogen, sulfur, or arsenic were studied in the presence of benzene and heavy water. The results confirm a charge-transfer-no-bond adsorption mechanism previously proposed for the deuteration of aromatic polycyclic hydrocarbons. For aromatic nitrogen compounds an increase in ionization potential of substrate leads to an increase in deuterium incorporation and a decrease in catalyst poisoning. Some aromatic amines deuterate faster than expected by theory and this is attributed to rapid exchange of the amino hydrogens in heavy water with a consequential increase in D–H ratio at the catalyst surface. Sulfur and arsenic, even in their saturated valency states, extensively poison benzene exchange as does triethylamine. p-Benzoquinone, 2,6-dichloroquinone, and NN-dimethyl benzylamine exhibit catalytic side reactions that poison benzene exchange. With tritium oxide, the technique is suitable for the synthesis of tritiated aromatic amines and heterocycles to high specific activity. (auth)

39084 THE DIMERIZATION OF TRIPHENYLCYCLOPROPENE. Ronald Breslow and Paul Dowd (Columbia Univ., New York). J. Am. Chem. Soc., 85: 2729-35 (Sept. 20, 1963).

When triphenylcyclopropene is converted to hexaphenylbenzene on treatment with sodium or lithium amide in liquid ammonia a simple dimer can be intercepted, triphenylcyclopropyl-triphenylcyclopropene (Ia). This dimer is also formed when triphenylcyclopropene is heated in refluxing xylene. Treatment of the dimer with potassium amide converts it to hexaphenylbenzene, while pyrolysis

of the dimer at 280° affords triphenylazulene and trans-stilbene. These unusual reactions were studied by a variety of techniques, and mechanisms are proposed for all of them. It is shown that triphenylcyclopropene is not converted to the triphenylcyclopropenyl anion by strong base, and from kinetic evidence a lower limit is placed on the pK_a of triphenylcyclopropene. (auth)

39085 ISOTOPE EFFECTS ON ACIDITY OF DEUTERATED FORMIC, ACETIC, PIVALIC, AND BENZOIC ACIDS. A. Streitwieser, Jr. and H. S. Klein (Univ. of California, Berkeley). J. Am. Chem. Soc., 85: 2759-63 (Sept. 20, 1963).

Conductivity measurements give the following results for $pK_D - pK_H$: DCOOH, 0.030 ± 0.004; CD_3COOH, 0.014 ± 0.002; C_6D_5COOH, 0.010 ± 0.002; 2,6-$C_6H_3D_2COOH$, 0.003 ± 0.001. The treatment of the isotope effects as normal inductive effects is discussed. (auth)

39086 THIOSUGARS. I. SYNTHESIS OF DERIVATIVES OF 2-AMINO-2-DEOXY-1-THIO-D-GLUCOSE. D. Horton and M. L. Wolfrom (Ohio State Univ., Columbus). J. Org. Chem., 27: 1794-1800(May 1962).

A range of derivatives of 2-amino-2-deoxy-1-thio-D-glucose, with removable blocking substituents at the amino and thiol groups, was synthesized by condensation of amino sugar glycosyl halides with thiourea, potassium thiolacetate, or potassium ethylxanthate. (auth)

39087 THIOSUGARS. II. REARRANGEMENT OF 2-(3,4,6-TRI-O-ACETYL-2-AMINO-2-DEOXY-β-D-GLUCOPYRANOSYL)-2-THIOPSEUDOUREA. M. L. Wolfrom, D. Horton, and D. H. Hutson (Ohio State Univ., Columbus). J. Org. Chem., 28: 845-7(Mar. 1963).

In neutral solution 2-(3,4,6-tri-O-acetyl-2-amino-2-deoxy-β-D-glucopyranosyl)-2-thiopseudourea dihydrobromide (I) undergoes rearrangement to form 3,4,6-tri-O-acetyl-2-deoxy-2-guanidino-1-thio-D-glucose (III). A product from the acetylation of I in acidic solution was identical with 1,3-di-N-acetyl-2-(2-acetamido-3,4,6-tri-O-acetyl-2-deoxy-β-D-glucopyranosyl)-2-thiopseudourea (II), which was prepared by acetylation of 2-(2-acetamido-3,4,6-tri-O-acetyl-2-deoxy-β-D-glucopyranosyl)-2-thiopseudourea hydrochloride (IV). The behavior of I and related derivatives on desulfurization is discussed. (auth)

39088 SYNTHESIS OF DICYCLOHEXYLAMMONIUM-NITRITE-1,1′-$C^{14}_{(2)}$. L. H. Schmidt, M. Bubner, and D. Doerr (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 6: 411-13(Aug. 1963). (In German)

The C^{14}-labeling of the dichans (dicyclohexyl ammonium nitrites) by chemical synthesis from calcium cyanide-C^{14} is described. (tr-auth)

39089 PRODUCTION OF LABELLED ANHYDROUS ZIRCONIUM AND HAFNIUM TETRACHLORIDES. W. Fischer (Inst. for Applied Physics, Dresden). Kernenergie, 6: 440-1(Aug. 1963). (In German)

Proceeding from the oxides of zirconium and hafnium, the anhydrous tetrachlorides were prepared by reactions with chlorine in the presence of carbon at 750°C. The separation of the tetrachlorides was successful for large amounts without difficulty. (M.C.G.)

39090 A SIMPLE PREPARATION OF 5-IODO-2′-DEOXYURIDINE LABELLED WITH IODINE-131 USING IODINE MONOCHLORIDE. A. D. Brownstone (National Inst. for Medical Research, London). Nature, 199: 1285 (Sept. 28, 1963).

A method of preparing 5-iodo-2′-deoxyuridine that gives consistent yields of 65 to 75% and I^{131} uptakes of 55 to 60% of the I^{131} used is described. Carrier-free NaI^{131} was obtained, and for each preparation a fresh solution of iodine monochloride was made. The iodine monochloride and deoxyuridine were heated together, and the product was purified by ion exchange. (M.C.G.)

39091 INFRARED SPECTROSCOPIC STUDY OF DEUTERATED PYRAZINES. H.-H. Perkampus and E. Baumgarten (Technische Hochschule, Hannover). Spectrochim. Acta, 19: 1473-9(Sept. 1963). (In German)

Two methods on how to prepare D_4-pyrazine by H–D-exchange are discussed. The infrared spectra of samples of different degree of deuteration are given. By a study of the intensities of bands and their dependence of the degree of deuteration it was possible to assign the bands to the different D-pyrazines. (auth)

39092 DISSOCIATION CONSTANTS OF SOME ACIDS IN DEUTERIUM OXIDE. R. P. Bell and A. T. Kuhn (Oxford Univ.). Trans. Faraday Soc., 59: 1789-93(Aug. 1963).

Spectrophotometric measurements were used to measure the dissociation constants of four dinitrophenols and nine carboxylic acids in H_2O and D_2O. There is no evidence for a relation between $pK_D - pK_H$ and pK for the carboxylic acids, though such a relation is probable for phenols and alcohols. (auth)

39093 SATURATED FLUOROCARBON ORGANO SILICON COMPOUNDS AND DERIVATIVES THEREOF AND METHODS OF MAKING THEM. (to Minnesota Mining and Manufacturing Co.). British Patent 935,380. Aug. 28, 1963. Priority date Oct. 23, 1958, United States.

Saturated fluorocarbon organosilanes and organosiloxanes and methods for producing them are patented. The compounds are valuable as intermediates in the synthesis of polymeric materials having superior solvent resistance and usefulness under wide ranges of temperature. They are particularly useful as surface-treating or coating agents to obtain water- and oil-repellent surfaces. The preparation of the organosilanes includes reacting a silane and a saturated fluorocarbon sulphonyl halide in the presence of a free radical initiator to form the organosilane and liberate SO_2. Various compositions of the compounds are specified. (M.P.G.)

Radiation Chemistry and Radiochemistry

Refer also to abstract 40396.

39094 (AECL-1800) RADIOLYSIS IN A STEAM-COOLED IN-PILE LOOP. J. E. LeSurf, R. E. Johnson, and G. M. Allison (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). July 1963. 10p. (CONF-213-1)

From Symposium on Water Chemistry in Reactors, Rome, May 1963.

A steam-cooled loop was constructed in NRX, Chalk River, Canada, as part of a joint UKAEA/AECL development program on water reactors. Chemistry experiments in this loop showed that ammonia present in the steam is radiolytically degraded to nitrogen and hydrogen with an approximate G value of 2 molecules/100 ev. With addition of oxygen to the coolant, there is evidence of the formation of oxides of nitrogen in-pile. The radiolytic degradation of dry steam is shown to be inhibited by excess hydrogen and to a lesser extent by ammonia. The implications of this work on future reactor development are discussed. (auth)

39095 (AERE-R-4048) RADIATION AND THERMAL STABILITY OF SOME POTENTIAL ORGANIC MODERATOR-COOLANTS. PART VII. THE EFFECT OF RADIATION INTENSITY ON THE DECOMPOSITION OF PARATERPHENYL BY FAST ELECTRONS. A. W. Boyd (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Aug. 1963. 8p.

The yields of gas and polymer in the electron irradiation of paraterphenyl show little or no dependence upon the rate of energy absorption over the range 0.24 to 10 watts/g. (auth)

39096 (BNL-6813) POLYMERIZATION IN SOLID SOLUTIONS OF ACRYLAMIDE IN PROPIONAMIDE. G. Adler and W. Reams (Brookhaven National Lab., Upton, N. Y.). Mar. 7, 1963. Contract AT-30-2-GEN-16. 11p.

It has previously been shown that the polymer formed in solid state polymerization of acrylamide is amorphous in spite of the fact that the reaction takes place within a crystalline solid. The stage at which it becomes amorphous is not known at present. Work with dilute solid solutions of acrylamide in propionamide suggests that this occurs after the addition of, at most, a very few monomer units. (auth)

39097 (CONF-224-2) PULSE RADIOLYSIS STUDIES OF THE REACTIVITY OF THE SOLVATED ELECTRON IN ETHANOL AND METHANOL. Irwin A. Taub, Myran C. Sauer, Jr., and Leon M. Dorfman (Argonne National Lab., Ill.). [June 20, 1963]. Contract [W-31-109-eng-38]. 9p.

From the Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

By means of the pulse radiolysis technique, a short-lived transient species was observed in irradiated de-aerated ethanol and methanol, exhibiting an optical absorption throughout the visible and near infrared. This transient is suggested to be the solvated electron on the basis of the nature of the spectrum, the reactivity with hydrogen ion and with various organic electron acceptors, and the formation of mononegative ions of some of these acceptors. The absolute rate constants were determined for the reactions of the solvated electron with hydrogen ion, oxygen, and benzyl chloride in ethanol and methanol. The diphenylide ion was found to be short-lived in ethanol. The absolute rate constant for the first-order decay of the diphenylide ion has been determined. (auth)

39098 (CONF-224-5) REACTIONS OF THE HYDRATED ELECTRON. S. Gordon, E. J. Hart, M. S. Matheson, J. Rabani, and J. K. Thomas (Argonne National Lab., Ill.). [June 17, 1963]. Contract [W-31-109-eng-38]. 14p.

From the Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

The rate constants for the reaction of the hydrated electron e^-_{aq} with a number of solutes and with radicals formed in water radiolysis are reported. Hydrated electrons were formed in the electron pulse irradiated solutions at concentrations in the range from 1 to 10 μM. Their reaction was followed by the decay of the optical absorption of e^-_{aq} at 5780 Å. Generally a 0.4 μsec pulse of 15 Mev electrons was used. In the absence of e^-_{aq} scavengers, second-order kinetics prevailed owing to the dominance of the reactions, $e^-_{aq} + e^-_{aq}$, $e^-_{aq} + H$, and $e^-_{aq} + H_2O_2$ when OH radical scavengers were present in alkaline solution. An analysis of the decay curves leads to values for $k_{e^-_{aq}+e^-_{aq}}$ and $k_{e^-_{aq}+H}$ of 0.9×10^{10} and 3×10^{10} M^{-1} sec^{-1}, respectively. With scavenger present in excess over $[e^-_{aq}]$, pseudo first-order kinetics were found and rate constants for a number of inorganic and organic compounds are reported. The agreement of these and other rate constants with diffusion-controlled reaction theory is discussed. (auth)

39099 (CONF-224-6) GAS-PHASE RADIOLYSIS OF PROPANE. EFFECT OF PRESSURE AND ADDED INERT GASES. P. Ausloos, S. G. Lias, and L. B. Sandoval (National Bureau of Standards, Washington, D. C.). [May 31, 1963]. 9p.

From the Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

The direct and inert-gas radiolysis, as well as the vacuum ultraviolet photolysis of $CD_3CH_2CD_3$, $CH_3CD_2CH_3$ and $C_3H_8 + C_3D_8$ mixtures were investigated in the presence of radical scavengers. The major conclusions are: (a) at atmospheric pressures, neutral propane decomposition contributes to the observed products although to a lesser extent than parent ion decompositions; (b) a variation in pressure has a pronounced effect on the fragmentation of the parent ion; (c) the hydrogen atoms in the ethyl ion are randomized in the direct as well as in the inert-gas sensitized radiolysis; (d) rearrangement in the parent ion is of minor importance in the radiolysis; (e) although the formation of propylene is related to the propyl ion, it is not necessarily produced by the neutralization of this ion. (auth)

39100 (CONF-224-7) REACTIONS IN TRACKS OF HIGH ENERGY PARTICLES. RADIOLYSIS OF OXYGEN. Kenji Fueki and John L. Magee (University of Notre Dame, Notre Dame, Ind.). [June 4, 1963]. Contract [AT(11-1)-427]. 16p.

From the Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

An a priori calculation of the radiolysis of oxygen gas in the pressure range 10^{-3} to 100 atm was made. In the low background region (1–100 atm) all track effects were considered. The calculated $G(O_3)$ values seem to be in reasonable agreement with experiment if only one excited oxygen molecule is initially formed per ion pair. Effects of pressure, LET, and dose rate are discussed. The radiation-induced chain decomposition of O_3 was not considered. (auth)

39101 (HW-75943) SEPARATION OF TECHNETIUM FROM MIXED FISSION PRODUCTS BY SOLVENT EXTRACTION WITH TRIBUTYL PHOSPHATE. M. H. Campbell (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 20, 1962. Contract AT (45-1)-1350. 11p.

Pertechnetate was found to extract quantitatively in a 45% tributyl phosphate–1M sulfuric acid system. Distribution ratios were determined as functions of hydrogen ion molarity and tributyl phosphate concentration. Sodium fluoride, added to the extraction system and an aqueous scrub, provided the necessary zirconium-niobium decontamination. A cation exchange column was used just prior to mounting to provide decontamination from metallic ions such as uranium. The overall decontamination provided by this method was 2×10^4 for zirconium–niobium-95 and 1×10^4 for ruthenium-103-106. The method can be completed in 45 minutes with a pertechnetate recovery of 92%, and a precision at the 95 per cent confidence level of ±1.6 per cent. (auth)

39102 (NAA-SR-Memo-2957) DECOMPOSITION RATES FOR POLYPHENYL REACTOR COOLANTS. D. W.

Bareis and R. H. J. Gercke (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 24, 1958. Contract AT-11-1-GEN-8. 9p.

A brief outline is presented of the results of the experimental program on polyphenyl decomposition rates, from the laboratory-scale capsule irradiations to the OMRE. The decomposition rates are tabulated for the terphenyls, Santowax OM and R, diphenyl, and OMRE coolant. The calculation of the coolant makeup rate for the SENN reactor is considered. (D.L.C.)

39103 (NARF-63-4T) ELECTRON-SPIN MAGNETIC RESONANCE OF FREE-RADICAL INTERMEDIATES IN GAMMA-IRRADIATED HYDROCARBONS. J. A. Staples, III (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Apr. 12, 1963. Contract AF33(657)-7201. 93p. (AD-417705; MR-N-299)

Results of a study of the character and origin of the electron-spin magnetic-resonance spectra of gamma-irradiated hydrocarbon compounds are presented. The compounds examined include selected alkanes, alkenes, alkynes, branched alkanes, and cycloparaffins. All irradiations and resonance measurements were performed at 77°K. Spectral analysis was directed toward identification of the chemical species responsible for the observed hyperfine patterns. Structural interpretation was confined to free-radical species resulting from carbon-hydrogen and carbon-carbon bond scission in the parent molecule. These results are incorporated into an evaluation of the current status of free-radical spectra from irradiated hydrocarbons. (auth)

39104 (NP-13076) STRAHLENCHEMISCHE REAKTIONEN AUSGEWAHLTER AZOVERBINDUNGEN. (Radiochemical Reactions of Selected Azo Compounds (thesis)). Hans-Reiner Kopp (Max-Planck-Institut für Kohlenforschung, Mulheim an der Ruhr, Germany). 1962. 114p.

The photoisomerization of azo esters, photolysis of azo compounds, radiochemically induced radical reactions with azo compounds, azodicarboxylic acid diethyl ester as a desensitizer, and the photoreaction of azo esters with isopropanol as sensitized by zinc tetraphenylporphyrin are discussed from a theoretical standpoint and experimental results are described. (M.C.G.)

39105 (NP-13077) STRAHLENCHEMISCHE UNTERSUCHUNGEN AN METALLORGANISCHEN VERBINDUNGEN. 1. ZINNORGANISCHE PHOTOPEROXYDE ALS NEUE TYPEN METALLORGANISCHER PEROXYDE. 2. STRAHLENCHEMISCHE REAKTIONEN DES FERROCENS MIT HALOGENKOHLENWASSERSTOFFEN. (Radiochemical Study on Metallorganic Compounds. 1. Tin Organic Photoperoxide as a New Type of Metallorganic Peroxide. 2. Radiochemical Reactions of Ferrocens with Halogen Hydrocarbons (thesis)). Horst Koeller (Max-Planck-Institut für Kohlenforschung, Mülheim an der Ruhr, Germany). 1962. 209p.

Triphenyltincyclopentadienyl was changed through photosensitized oxygen transfer into triphenyltincyclopentadienyl endoperoxide. The structure of the compound was determined. Photosensitization of oxygen transfer to triphenyl-(3-methylbuten-(2)-yl)-tin and to triphenyl-(2,3-dimethylbutene-(2)-yl)-tin led to two tin-organic hydroperoxides. Ferrocene reacted with carbon tetrachloride and carbon tetrabromide under the influence of radiation to form ferricinium tetrachloroferrate (III) and ferricinium tetrabromoferrate (III). The G values were calculated. Radiochemical studies of tin-organic compounds are also discussed. (M.C.G.)

39106 (SGAE-1963/2) BESTIMMUNG VON Ba-140 AUS URANSPALTPRODUKT-GEMISCHEN. (Determination of Ba-140 from Uranium Fission-Product Mixtures). H. Sorantin, H. Bildstein, and B. Bauer (Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Vienna). [1963]. 17p.

The effectiveness of the individual steps in the precipitation method for the separation of Ba^{140} from uranium fission products was investigated. The barium was precipitated as $BaCl_2 \cdot 2H_2O$ and spectra were measured at each step. (M.C.G.)

39107 (TID-18777) EVIDENCE FOR POSITIVE IONS WITH ACIDIC CHARACTER IN THE RADIATION CHEMISTRY OF LIQUID HYDROCARBONS. W. R. Busler, D. H. Martin, and Ffrancon Williams (Tennessee. Univ., Knoxville). [1963]. Contract AT(40-1)-2968. 10p. (CONF-224-3)

From the Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

A study was made of the effect of ammonia and amines on the radiation-induced polymerization of cyclopentadiene. The marked retardation of the reaction at low concentrations of ammonia furnishes decisive proof for the participation of ionic intermediates. It was also shown that the irradiation of cyclohexane containing dissolved ND_3 leads to HD formation in excess of "statistical expectation." This result accords with the prediction of proton transfer from cyclohexane ions to ND_3. Calculations based on the experimental results indicate that ion lifetimes are greater in cyclopentadiene than cyclohexane. Conditions which may determine the rates of neutralization of ions are discussed. (auth)

39108 (TID-19439) SEPARATION AND ANALYSIS OF OMRE CORE II FLUID BY COLUMN FRACTIONATION. Report No. 20. M. L. Burrous, W. F. Haddon, and R. O. Bolt (California Research Corp., Richmond). June 30, 1963. Contract AT(04-3)-248. 22p.

In a study on the composition of spent reactor coolants, a special column fractionation technique was used on coolant from the Core II operation of the Organic Moderated Reactor Experiment (OMRE). This procedure separated the fluid into fractions on the basis of differential solubility in chloroform-hexane mixtures. These individual fractions were then characterized by gas chromatography (GC), mass spectrometry, infrared spectrophotometry, elemental analysis, and molecular weight determinations. In addition to unchanged terphenyls, the more soluble fractions contained higher polyphenyls, polyphenylenes, alkylpolyphenyls, and condensed-ring aromatics. The least-soluble fractions (~8% of the total) had three striking characteristics: (1) low carbon-to-hydrogen ratio, (2) high oxygen content, and (3) high chlorine content. These least-soluble fractions also had number average molecular weights lower than those of several of the more soluble cuts. Thus, used OMRE fluid contains a relatively insoluble organic portion that is not polyphenyl in nature and whose insolubility is not related to high molecular weight. The concentration of both oxygen and chlorine in the relatively insoluble portion implies that it would form a film on heat transfer surfaces. These elements have each been shown in past work to play a part in the fouling process. The low carbon-to-hydrogen ratio is consistent with the theory that this portion of the coolant is formed by the polymerization of hydrogenated polyphenyls, e.g., cyclic dienes. (auth)

39109 (TID-19440) PETROLEUM REFINERY STREAMS AS NUCLEAR REACTOR COOLANTS–RADIO-

LYTIC PRODUCT INVESTIGATIONS. Report No. 21. M. L. Burrous and R. O. Bolt (California Research Corp., Richmond). June 30, 1963. Contract AT(04-3)-248. 19p.

Petroleum refinery stocks of widely varying composition were irradiated with gamma rays ($\sim 5 \times 10^9$ rads) at 600°F and the resulting high boiling products isolated. The objective was to determine how these radiolytic residues compare in solubility, etc., properties with those from radiolyzed terphenyls. Superiority of the refinery stream residues would point to a decreased tendency to "plate out" on heat transfer surfaces and provide an incentive, other than possible make-up cost savings, for using refinery streams as nuclear reactor coolant-moderators. The best refinery materials were found to produce radiolytic residues that were less soluble and more intractable than the radiolytic polymer from terphenyls. These refinery stream residues were also formed at faster rates than was that from terphenyls. Thus, the characteristics of radiolytic polymer from refinery streams are at least as undesirable as those of polyphenyl residues, and the feasibility of employing refinery stocks as reactor coolant-moderators must depend primarily on a balance between unit coolant costs and rate of decomposition. It seems unlikely that the demonstrated pyrolytic and radiolytic instability of the refinery streams relative to polyphenyls can be offset sufficiently by their low unit cost to justify their use. (auth)

39110 (UCLA-517) THE RADIATION CHEMISTRY OF PAPAIN IN DILUTE AQUEOUS SOLUTIONS. L. S. Myers, Jr., and John Leo Abernethy (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). Aug. 1963. Contract AT-04-1-GEN-12. 24p.

The effects of Co^{60} gamma irradiation on solutions of crystalline papain were investigated by means of ultraviolet and infrared spectrometry, ultracentrifugation, appearance of opalescence and turbidity, and determination of the ability of the enzyme to catalyze the hydrolysis of N-benzoyl-L-arginine amide. The catalytic activity decreased exponentially with radiation dose in air-saturated solutions for any given initial activity. The initial yields, however, almost doubled as the enzyme concentration was increased from 45 to 360 mg per 100 ml. Displacement of air by He had essentially no effect on the yields. The catalytic activity was lost more rapidly at pH values of 3.0 and 9.0 than at the natural pH of 5.35. The ultraviolet absorption spectrum showed a decreased at the 280 mμ peak with small radiation doses, then increased greatly at all wave lengths with higher doses. Opalescence and turbidity occurred in irradiated solutions having pH values of 7 or greater. The infrared and Schlieren patterns of 1% solutions showed essentially no change. (auth)

39111 DOSIMETRY OF IONIZING RADIATION BY REACTION WITH NITROGEN. M. T. Dmitriev. At. Energ. (USSR), 15: 52-9(July 1963). (In Russian)

The amount of NO_2 formed by irradiating air or a nitrogen–oxygen mixture is a measure of the radiation dose. The G yield for the formation of NO_2 does not depend on the type of radiation but is dependent on temperature. The G yield in molecules of NO_2 per 100 ev is 1.35 at 0°C, 1.38 at 10°, 1.39 at 15°, 1.41 at 20°, 1.43 at 25°, and 1.46 at 30°C. A dose of 1 r corresponds to the following concentrations of NO_2 in air at 760 mm Hg std (in wt.%): 0.64×10^{-8} at 0°C, 0.66×10^{-8} at 15°C, and 0.67×10^{-8} at 20°C. The concentration of NO_2 also depends on the composition of the nitrogen–oxygen mixture, the temperature, and pressure. The concentration of NO_2 is directly proportional to the dose up to 1.5×10^9 rads: $[NO_2] = kE$. Here $[NO_2]$ is the concentration of NO_2 in wt.%; E is the absorbed dose in rads, and k is a proportionality coefficient. At a temperature of 20°C and a pressure of 1 atm, the value of k is 5.12×10^{-9} for air, 2.86×10^{-9} for 90% N_2 + 10% O_2, 6.72×10^{-9} for 70% N_2 + 30% O_2, 7.98×10^{-9} for 50% N_2 + 50% O_2, and 4.08×10^{-9} for 15% N_2 + 85% O_2. The value of k can be calculated for other compositions from the following equation: $k = 32.0\ n\ (1\text{-}n)\ 10^{-9}$, where n is the mole fraction of nitrogen in the gaseous mixture. The G yield of NO_2 increases with increasing pressure above 1 atm, but does not exceed 6 molecules of NO_2/100 ev. Values of k are given at various pressures and temperatures. The G yield of NO_2 decreases on increasing the temperature above 200°C because of the thermal decomposition of NO_2 into NO and oxygen. (TTT)

39112 THE RADIOLYSIS AND PHOTOLYSIS OF CYCLOHEPTATRIENE. Shigeyoshi Arai, Michio Maemori, Kenji Yamaguchi, and Shoji Shida (Tokyo Inst. of Tech.). Bull. Chem. Soc. Japan, 36: 590-4(May 1963). (In English)

In the photosensitized reaction of cycloheptatriene vapor, toluene was produced as the result of isomerization. The amount of toluene formation decreases as the pressure of cycloheptatriene increases. Isomerization to toluene proceeds through the excited molecule, which may be collisionally deactivated. ESR experiments at low temperatures show that cycloheptatrienyl radicals are formed by electron irradiation. However, the yield of the radical formation is low, nearly equal to that of benzene. In the radiolysis of liquid cycloheptatriene the G values of the gaseous products and toluene are very small. The G value of the polymer seems to suggest the low yield of the radical formation at the initial step. It was concluded that the major part of the absorbed energy results in the formation of the excited molecule, the electronic energy of which is readily converted to thermal energy. (auth)

39113 THE SEPARATION AND DETERMINATION OF RUTHENIUM IN FISSION PRODUCTS BY LIQUID-LIQUID EXTRACTION WITH PYRIDINE. Toshiyasu Kiba, Akiko Miura, and Yasuyuki Sugioka (Kanazawa Univ., Japan). Bull. Chem. Soc. Japan, 36: 663-9(June 1963). (In English)

A method of separating radioactive ruthenium from fission products and technetium in an aqueous solution containing sodium hydroxide and hypochlorite by liquid-liquid extraction with pyridine is discussed. In the process, ruthenium in various ionic forms and various oxidation states is oxidized to perruthenate with the hypochlorite, and the perruthenate is transferred into pyridine from the aqueous solution. The partition coefficient of perruthenate was estimated for the carrier-free and the carrier-containing cases, as well as for the case where other fission products were present. Good separation of radioactive ruthenium from other fission products was achieved with a large decontamination factor. The results were examined by a γ-ray spectrum measured at each step of the extraction process. (P.C.H.)

39114 PREPARATION OF RADIOACTIVE ANTIMONY-120 OF A HIGH SPECIFIC ACTIVITY BY THE IRRADIATION OF TIN WITH PROTONS. Kazuo Saito, Nobuo Suzuki, Kunio Seto, and Hidetsugu Ikegami (Tokyo Univ.). Bull. Chem. Soc. Japan, 36: 692-6(June 1963). (In English)

By irradiation of a tin target (antimony content, less than 8×10^{-4}%) with 15 Mev protons (120 μ amp hr), about 1 mC of Sb^{120} was produced, with a specific activity more than 30 μC per μg of antimony. The radioactive antimony was either separated by extraction with amylacetate from more than 6 N hydrochloric acid containing tin(IV) or by cation

exchange in a 0.4% tartaric acid solution of pH 0.6 to 1.6 containing tin(II). Sb^{120} is electrolytically deposited on an evaporated film of silver or copper from a 1 to 3 N hydrochloric acid solution containing 1% hydroxylamine hydrochloride with a yield of 70% within 3 hr. Care should be taken to avoid hydrolytic aging of antimony in diluted hydrochloric acid, which vitiates the extraction, the ion exchange, and the electrolysis. (auth)

39115 THERMAL AND RADIATION OXIDATIONS OF BENZENE TO PHENOL IN AQUEOUS SOLUTIONS CONTAINING METAL IONS AT ELEVATED TEMPERATURES. I. THE THERMAL BEHAVIOR OF IRON SULFATE AND CHLORIDE IN AQUEOUS SOLUTIONS WITHOUT BENZENE. Hiroshi Hotta and Nobutake Suzuki (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan, 36: 717-21(June 1963). (In English)

The rate of the ferrous oxidation at 150°C is 6.10×10^{-4} sec^{-1} for sulfate, and 2.78×10^{-4} sec^{-1} for chloride at the oxygen pressure of 30 atm. The precipitation reaction of iron species is through hydrolyzed ferric ions even in the ferrous solution. The rate of precipitation for ferric sulfate is given, with the activation energy of 12.5 kcal/mole. The precipitate is amorphous at 100°C and completely α-Fe_2O_3 at 200°C. (auth)

39116 THERMAL AND RADIATION OXIDATIONS OF BENZENE TO PHENOL IN AQUEOUS SOLUTIONS CONTAINING METAL IONS AT ELEVATED TEMPERATURES. II. THE EFFECT OF IRON SULFATE AND CHLORIDE ON PHENOL YIELD. Hiroshi Hotta, Akira Terakawa, Kazuo Shimada, and Nobutake Suzuki (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan, 36: 721-7 (June 1963). (In English)

In a ferric sulfate solution, benzene can be oxidized to phenol with a good yield above 170°C, when not irradiated, but at lower temperatures, when irradiated. In the ferrous sulfate solution, the yield of phenol is independent of irradiation, and somewhat larger than in the irradiated ferric sulfate solution. Such a high yield of phenol is due to the complexing of hydroxycyclohexadienyl peroxy radical, produced with OH radical and oxygen dissolved, with ferrous ions. (auth)

39117 STUDIES OF THE RECOIL TRITIUM-LABELING REACTION. Teruhiko Meshi and Yoshishige Sato (Tanabe Seiyaku Co., Ltd., Osaka). Bull. Chem. Soc. Japan, 36: 750-1(June 1963). (In English)

Studies were made on the incorporation of recoil tritium into glucose, lactose, and α-hydroximinopropionic acid. The method is described and data are tabulated. (P.C.H.)

39118 REARRANGEMENT STUDIES WITH C^{14}. XVI. REARRANGEMENTS INDUCED BY γ-IRRADIATION OF 2-PHENYLETHYL-1-C^{14} BROMIDE OR 2-p-METHOXYPHENYLETHYL-1-C^{14} BROMIDE. D. P. Thornhill and C. C. Lee (Univ. of Saskatchewan, Saskatoon, Can.). Can. J. Chem., 41: 2482-6(Oct. 1963).

Irradiation of 2-phenylethyl-1-C^{14} bromide with up to 133 million rads of Co^{60} γ rays gave 2-phenylethyl-2-C^{14} bromide with a mean G_r of 0.30 ± 0.01. Similar studies with 2-p-methoxyphenylethyl-1-C^{14} bromide resulted in 2-p-methoxyphenylethyl-2-C^{14} bromide with a mean G_r of 0.46 ± 0.04. Monomeric, liquid organic products were found to be benzene, ethylbenzene, and styrene, or the analogous p-methoxy derivatives, from the irradiation of 2-phenylethyl bromide or 2-p-methoxyphenylethyl bromide, respectively. Possible mechanisms for the radiation-induced isotope position rearrangements are discussed. (auth)

39119 COMPOUND FORMATION BY γ-IRRADIATION OF XENON–FLUORINE MIXTURES. Donald R. MacKenzie and Richard H. Wiswall, Jr. (Brookhaven National Lab., Upton, N. Y.). Inorg. Chem., 2: 1064(Oct. 1963). (BNL-6774)

Mixtures of Xe and F_2 in slightly greater than 2:1 mole ratio of F_2 to Xe were exposed, in prefluorinated nickel containers, to high-intensity gamma radiation from Co^{60} sources. The pressure was observed to fall, as it would if the two elements combined, and a solid product was later obtained from the container, by sublimation. Results of analysis of the compound indicated a composition $XeF_{3.0}$, suggesting a mixture of difluoride and tetrafluoride. (P.C.H.)

39120 RADIOLYSIS OF CARBON TETRACHLORIDE IN THE PRESENCE OF AIR AND OXYGEN. Z. Spurný (Inst. of Nuclear Research, Prague). Intern. J. Appl. Radiation Isotopes, 14: 337-40(Aug. 1963). (In English)

In the radiolysis of CCl_4, it was found that very strict differentiation must be made according to its purity, presence of oxygen, presence of dry-air, and presence of air with water-vapor. Estimation of yields, influence of temperature and oxygen, and the mechanism of radiolysis are described. (P.C.H.)

39121 THE EXTRACTION OF CARRIER-FREE I^{131}. L. J. Anghileri (Volk Radiochemical Co., Chicago). Intern. J. Appl. Radiation Isotopes, 14: 381-3(Aug. 1963). (In English)

The extraction of carrier-free I^{131} with various organic solvents was studied using chloroform, petroleum ether (bp 60-90 C), carbon tetrachloride, and isopropyl ether. The influence of salt concentration was studied in a series of extractive procedures with chloroform, using sodium chloride, sodium sulfate, and urea. Carrier-free I^{131} was liberated in each case from the carrier-free I^{131} solution using sodium nitrite, adjusting the pH to different values within a range from 0.1 to 4.0. (P.C.H.)

39122 DIFFRACTION STUDIES OF PHOTOCHEMICAL DECOMPOSITION OF AZIDES. I. X-RAY AND UV-INDUCED LATTICE CONSTANT CHANGES IN TlN_3. Brigitte H. Krause (Army Engineer Research and Development Labs., Fort Belvoir, Va.). J. Chem. Phys., 39: 1706-13 (Oct. 1, 1963).

Diffraction methods were applied to study irradiation and annealing effects on TlN_3. Crystallographic lattice constant and cell volume changes upon x irradiation were determined as function of irradiation time and radiation intensity. From the character of these curves some conclusions were drawn about the physical processes causing the effects. The reversibility of these processes was studied by annealing experiments at various temperatures and in both air and helium atmospheres. Preliminary studies of radiation damage on uv-irradiated samples were carried out in order to relate the diffraction results to the TlN_3 absorption spectrum and photoconductivity data. (auth)

39123 FRAGMENTATION OF THE EXCITED PARENT IONS, $[CH_3Kr^{82}]^+$ AND $[CH_3O^{18}]^-$, FOLLOWING THE β^- DECAY OF CH_3Br^{82} AND THE β^+ DECAY OF CH_3F^{18}. Thomas A. Carlson and R. Milford White (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 39: 1748-52(Oct. 1, 1963).

The relative abundances of the fragment ions that result, respectively, from the β^- decay of CH_3Br^{82} and β^+ decay of CH_3F^{18} were measured with a specially designed mass spectrometer. Following the β^- decay of CH_3Br^{82}, only about 0.4% of the parent ion, CH_3Kr^+, remained intact, as was anticipated from the rather large recoil energy. The most abundant ion observed was CH_3^+, 89%. A variety of other ions were also formed and their production is dis-

cussed in terms of excitation resulting from a sudden change in nuclear charge. The following negative ions were detected in positron decay of CH_3F^{18}: CH_3O^-, O^-, and H^-. A large abundance of positive ions, however, was also observed. The origin of these positive ions is critically discussed; and calculations of the probabilities for electron shakeoff following both positron and negatron decay are given for several atomic systems. (auth)

39124 SPONTANEOUS DECOMPOSITION OF TRITIUM-MARKED THYMIDINE IN AN AQUEOUS SOLUTION. Sonia Apelgot and Bernard Ekert (Universite, Paris). J. Chim. Phys., No. 4, 505-9(1963). (EUR 381.f). (In French)

A paper-chromatographic study was made of the decomposition products formed at 4°C in an aged solution of tritium-marked thymidine. The results show good correlation between the products formed in the course of such spontaneous decomposition and those resulting from x irradiation at 0°C of cold thymidine in solution. (auth)

39125 X-RAY-INDUCED UNPAIRED SPINS IN NUCLEIC ACID BASES AND IN 5-BROMOURACIL. A. Mueller, W. Koehnlein, and K. G. Zimmer (Kernforschungszentrum, Karlsruhe, Ger.). J. Mol. Biol., 7: 92-4(July 1963).

Quantitative determinations were made of the energy required for the formation by x or γ rays of a free radical (unpaired spin) in nucleic acid bases and in one analog: 5-bromouracil. The materials were irradiated in the form of dry powders with 100- to 150-kv x rays or with γ rays from a Co^{60} source. The energies required for the production of one unpaired spin in nucleic acid bases range from 120 to 1400 ev. These values are compared to those obtained for amino acids containing an aromatic ring (170 to 2500 ev), whereas the values for aliphatic amino acids fall between 20 and 80 ev. The pair cytosine-guanine (C : 350 ev and G : 150 ev) require considerably less energy for the formation of an unpaired spin than the pair thymine-adenine (T : 1400 ev and A : 1200 ev). This difference may be of importance for explaining the observation that in bacteria the mean lethal dose for x rays decreases with increasing ratio CG/TA. The energy required for the formation of one unpaired spin in 5-bromouracil is 160 ev as compared to 1400 ev for thymine. The difference observed between the natural base and its analog has a bearing on the sensitization toward x-ray damage after incorporation of the analog into phage, micro-organisms, or mammalian cells. The results are not due to an increase of total energy absorption by photoelectric absorption in Br which is negligible, if not absent, with Co^{60} γ rays. With relatively soft x rays the additional effect of photoelectric absorption is very noticeable in pure bromouracil (42% Br by weight) though in heavy T phage (containing about 1% Br by wt) the additional effect of photoelectric absorption would be much less pronounced even with x rays. Consequently, the sensitization towards radiation damage after incorporation of 5-bromouracil into biological entities is, even with soft x rays, not likely due to the smaller energy needed for radical formation and not to additional absorption of energy by photoelectric processes. The energy required for the formation by x or γ rays of one unpaired spin in the bases (120 to 1400 ev) is higher than the energy needed for the same effect in whole nucleic acid. The latter was 160 ev in calf thymus DNA, 110 ev in yeast RNA, and 8 ev to 30 ev in different preparations of DNA from T phage. Therefore, free radicals formed in the bases would not be expected to be the most frequent source of radiation damage to DNA. (BBB)

39126 EFFECT OF Co^{60} γ RADIATION ON VITAMIN B_6-GROUP SUBSTANCES. Masahide Shiroishi (Food Research Inst., Tokyo). J. Vitaminol. (Kyoto), 7: 188-95 (Sept. 1961). (In English)

When aqueous solutions of 0.030 mg/ml pyridoxine hydrochloride, pyridoxal hydrochloride, and pyridoxamine dihydrochloride, the pH of which had been adjusted to ~2 with 0.01N hydrochloric acid, were irradiated with Co^{60} γ radiation at a dose of 10^5 rep, the loss of the vitamin was 94, 77, and 70%, respectively. Losses of less than 10% were noted at vitamin concentrations above 0.1 mg/ml. Decomposition of the vitamin was assayed by the colorimetric reaction employing diazotized sulfanilic acid and measurement of optical density at 420 mμ. The pH values of solutions of vitamin B_6 analogs were decreased by irradiation. However, decomposition of the vitamin by irradiation was independent of the pH value of the solution. Borate complexes of pyridoxine were not stable to γ irradiation. Stability of pyridoxine to radiation in several mineral acids (hydroiodic, hydrochloric, hydrobromic, sulfuric, and nitric) was also examined. In hydroiodic acid it was not decomposed at all, yet at the same time iodine was formed during irradiation. The maximum color intensity of the irradiated solution of pyridoxine was shown to be at 420 mμ and it increased with the radiation dose. Production of ammonia by the irradiated solution was determined by the spot test and the Conway method. The formation of ammonia was increased with radiation dose. (TCO)

39127 AN INTERPRETATION OF ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF IRRADIATED POLYETHYLENE. Hisatsugu Kashiwabara (Hokkaido Univ., Sapporo). Japan. J. Appl. Phys., 2: 523-6(Sept. 1963). (In English)

A short review on the behavior of the free radicals produced in irradiated polyethylene is presented, and a consistent interpretation of the trapping sites of the free radicals in polymers is proposed in connection with the morphological fact of polymer crystals. All the observed behavior of the stable free radicals of seven-line pattern can be interpreted by assuming that the radicals are trapped in the pseudocrystalline region in polyethylene (probably the folding part of crystal lamella). (auth)

39128 ON THE EFFECTS OF BREMSSTRAHLUNG FROM A 25 Bev BETATRON AND ULTRAVIOLET IRRADIATION ON MINERAL OILS. S. Z. Kaplan, A. P. Breydo, and I. F. Spirina. Khim. i Tekhnol. Topliv i Masel, No. 8, 57-61(Aug. 1963).

A study was made of the effects of bremsstrahlung from a betatron of 25-bev energy and ultraviolet irradiation on polymer thickened turbine oil. It was found that irradiation of the oil in a closed vessel with limited access to air in the betatron resulted in a decrease in the acid number and no change in the viscosity. Infrared spectra of oil irradiated in the betatron showed a decrease in intensity of the absorption lines corresponding to ethylene and methyl groups. After irradiation with ultraviolet light, the intensity of the lines increased again. Irradiation of transformer oil in the betatron in an open vessel resulted in an increase in acid number and a drop in electrical insulating properties. Another product of the irradiation was the appearance of beta-active isotopes Fe^{55} and Na^{24}. (OTS)

39129 MUTUAL RADIATION GRAFTING OF STYRENE ONTO CELLULOSE ACETATE. Hiroshi Sumitomo, Setsuo Takamuku, and Yoshikazu Hachihama (Osaka Univ.). Kogyo Kagaku Zasshi, 66: 269-71(Feb. 1963). (In Japanese)

A study of the γ-ray-induced mutual grafting of styrene onto cellulose acetate (combined acetic acid, 52.8%) showed that cellulose acetate enhances the rate of polymerization of styrene. Dilution of the monomer with benzene accelerates the polymerization, with a maximum effect occurring at 60 mole % styrene. Grafting efficiency increases as monomer concentration increases also with increasing total dose for benzene solution, but decreases for acetone and dimethyl formamide solutions. Graft copolymer was separated from both homopolymers by alternating repeated extractions with benzene and acetone as solvents. Molecular weights of polystyrene formed in different regions in the reaction system used were quite different from one another. They increased in the following order of polymerization sites: surrounding monomer solution phase < monomer solution inside the cellulose acetate film < grafting layer. Isolated graft copolymer was much richer in the styrene component, and soluble in tetrahydrofuran, dioxane, and dimethyl formamide, but insoluble in both benzene and acetone. Polystyrene grafted on acetyl groups and that on the rest of glucose units of the stock polymer were isolated, respectively, but alkali saponification and by acetolysis of the cellulose backbone. The grafted amounts of the respective products were not very different from each other. Apparently, grafting did not take place predominantly on a specific part of the backbone polymer chain. (BBB)

39130 NEW DATA ON THE EFFECTS OF RADIATION OF SOLID MATERIALS, AND ON THE EXTERNAL RADIATION ON SOME HETEROGENOUS CHEMICAL PROCESSES. I. V. Szpicin (Inst. of Physical Chemistry, Moscow). Magy. Tud. Akad. Kem. Tud. Oszt. Kozlemen., 18: 301-21(1962). (In Hungarian)

Previous studies of Mahaljenko, Finyikov, and Gromov are discussed. Later research confirms their findings that radiochemical activation of the surfaces of solids requires much smaller doses of radiation than other radiochemical processes. Experiments were conducted with radioactive compounds, such as sulfates of alkali metals (magnesium and barium sulfate), calcium phosphate, and cerium oxide. A study was made of the changes effected by S^{35} radiation on the speed of the isotope exchange reaction of two heterogeneous systems. The speed of the S^{35} reaction was studied in the $K_2SO_4-SO_3$ system at 840°C; activation of the K_2SO_4 was varied over the range 0.02–131 mC/g. The rate of isotope exchange was shown to be constant, (11–12% in 10 min), until it began to increase as the activity was raised above 0.05 mC/g. S^{35} radiation also influenced the oxygen isotope exchange in the system $Na_2SO_4-O_2^{18}$. Experiments were also conducted in the 620–790°C range. At 780°C the preparation with an activity of 0.08 mC/g showed an isotope exchange of 7.8%. $BaSO_4$ was prepared by taking 3 g of the precipitate formed from Ba^{2+} and SO_4^{2-} and shaking it together for 4 hr at 25°C with 15 ml of dye solution. Concentration of the dye varied from 10 to 200–250 mg/l; pH of the solution with acid orange was 5.5–5.8 and with methyl blue 6.2–6.9. By adding S^{35} isotopes to $BaSO_4$ preparations, it was found that the adsorption of methyl blue decreased, whereas that of the acid orange increased as compared to the adsorption capacity of inactive $BaSO_4$. Another finding was that a highly active $BaSO_4$ preparation stored for 100–200 days adsorbed methyl blue to a lesser degree than a freshly precipitated preparation of the same activity. (BBB)

39131 EFFECTS OF IRRADIATION ON ABSORPTION AND CATALYTIC CHARACTERISTICS OF SOLIDS. (REVIEW). László Guczi and Pál Tétényi (National Atomic Energy Commission Isotope Inst., Budapest). Magy. Tud. Akad. Kem. Tud. Oszt. Kozlemen., 18: 585-601(1962). (In Hungarian)

39132 A PLASTIC APPLICATOR WITH AN ACTIVE P^{32} LAYER BETWEEN TWO CAOUTCHOUC FOILS. M. Zaduban and E. Kunstadt (Sajarik Univ., Košice, Czechoslovakia). Neoplasma, 9: 501-6(1962). (In English)

The preparation of an applicator for use in radiotherapy of an enclosed β emitter is described. The applicator consists of two sheets of rubber between which there is a radioactive layer composed of cellulose powder and inorganic salt of P^{32}. The applicator is elastic and is suitable for brachycurietherapy. It may be used for several successive treatments; over a period of three months its elastic properties remain unchanged by the effect of radiation. For applicator preparation the following were used: various phosphorus salts, especially $Na_2HP^{32}O_4$ at a concentration of 14–16 mg P/ml, a solution of crude rubber in benzene, and powdered Whatman cellulose. The rubber solution is evaporated in a Petri dish coated with methylsilicone; a thin layer of cellulose powder is spread over the dried film of rubber, an aqueous solution containing P^{32} is poured on the powder, and after drying, another layer of rubber is evaporated on the surface to seal in the radioactivity. The cellulose layer on which the solution of P^{32} salt is evaporated serves as centers for the formation of small crystals, evenly distributed over the entire surface of the applicator. If inorganic salts of P^{32} are used in a concentration < 5 mg/cm² and without the cellulose layer, an inhomogeneous applicator is obtained. The usual surface activity of the applicators was 200–300 μC/cm². One of their advantages is the possibility of preparing the applicators in different dimensions with varying surface activities, as required by individual cases. A disadvantage lies in the fact that by stretching the applicator the compactness of the active layer may be damaged and it thus becomes worthless. If sufficient magnesium silicate (talcum) powder is applied the surface during application, the applicator will not adhere to the skin. (BBB)

39133 ON THE QUESTION OF PHOTOCONDUCTION IN CdS CLEAVAGE CELLS BY GAMMA EXCITATION. E. Schnuerer (Physical Technical Inst., Berlin). Phys. Status Solidi, 3: 1594-1602(1963). (In German)

In relation to the contaction question, the surface reactions on CdS single crystals in anodic glow are reported. From the photoelectric current–voltage behavior of CdS cleavage cells in gamma excitation, a cooperation of negative space charges for the photoconduction mechanism was deducted. From the ideas of Mott and Gurney on space-charge-boundary current in insulators were investigated in order to estimate the space-charge-boundary part of the photoelectric current in gamma-excited CdS crystals. (tr-auth)

39134 STUDIES ON THE COLORATION OF LiF CRYSTALS. P. Goerlich, H. Karras, and G. Koetitz. Phys. Status Solidi, 3: 1629-45(1963). (In English)

LiF crystals grown by two different methods (Bridgman/high vacuum and Kyropoulos/air) are colored by x-ray, deuteron, proton, and electron irradiation. The dependence of coloration spectra upon both the growth technique and the type of radiation used for coloring the crystals, was found to be negligible. Additive and electrolytic coloration experiments did not yield any selective absorption in the investigated range farn 200 to 3000 nm. (auth)

39135 PARAMAGNETIC RADICALS IN NITRATE DOPED POTASSIUM CHLORIDE. D. Schoemaker and

E. Boesman (Laboratorium voor Kristallografie en Studie van vaste Stoffen, Ghent). Phys. Status Solidi, 3: 1695-1703(1963). (In English)

A study was made of two paramagnetic resonance spectra found at room temperature in x-ray irradiated KCl doped in the melt with KNO_3. One spectrum could be ascribed to a NO molecule, probably in an anion vacancy, and the other to a N_2^{2-} molecular ion in an anion vacancy, both having approximately axial symmetry around a [100] direction. An unidentified resonance found by Sander is also discussed. This resonance is considered to be due to centers formed by N^- molecular ions in anion vacancies and having orthorhombic symmetry with [001], [110], and [1$\bar{1}$0] axes. (auth)

39136 PHYSICO-CHEMICAL EFFECTS OF NEUTRON CAPTURE IN LIQUID SYSTEMS. P. F. D. Shaw (Oxford Univ.). Radiochim. Acta, 1: 177-88(Aug. 1963). (In English)

Possible physical effects produced by the heating of a liquid in the vicinity of an atom activated by neutron capture were considered, and the results were used to calculate the yields of bromoethane obtained in bromoethane-bromine mixtures. The effects of change of temperature upon the yields were examined, and were in approximate agreement with those observed. (auth)

39137 THE SZILARD-CHALMERS REACTION IN POTASSIUM PERMANGANATE. Desire J. Apers and Garman Harbottle (Brookhaven National Lab., Upton, N. Y.). Radiochim. Acta, 1: 188-93(Aug. 1963). (BNL-6788). (In English)

The hot-atom reactions of recoil Mn^{56} in neutron irradiated potassium permanganate were investigated. In solutions of irradiated crystals at all pH values from 0 to 14 most of the non-permanganate activity was found in cationic (manganous or manganic) forms of Mn^{56} and not, as previously thought, in $Mn^{56}O_2$. At pH values more alkaline than 1, the cationic activity is tightly adsorbed onto traces of MnO_2 or added Al_2O_3. The pH sensitivity of the retention in $KMnO_4$ largely disappears if the crystals are annealed before analysis. (auth)

39138 CHEMICAL EFFECTS OF NUCLEAR RECOIL. ALKALI BROMATES. D. J. Apers (Universite de Louvain, Belg.), F. G. Dejehet, B. S. van Outryve d'Ydewalle, P. C. Capron, J. Jach, and E. Moorhead. Radiochim. Acta, 1: 193-9(Aug. 1963). (In English)

An attempt was made to explain some of the discrepancies that were observed during studies on the retention of bromine in neutron irradiated bromates. In particular the influence of solvent, irradiation time, and thermal annealing was investigated in potassium bromate, lithium (natural abundance) bromate, and lithium (depleted in Li^6) bromate. Experiments show that a considerable amount of neutral bromine is formed upon recoil, and that the abnormal behavior of lithium bromate is due to the consequences of $Li^6(n,\alpha)T$ reactions. An explanation is put forward on the basis of an oxygen free intermediate recoil bromine fragment. The isotope effect on bromine recoil was confirmed. (auth)

39139 FURTHER STUDIES ON RADIOCOLLOIDS. H. Reinhardt, J. O. Liljenzin, and R. Lindner (CCR Euratom, Ispra, Italy). Radiochim. Acta, 1: 199-203(Aug. 1963). (In English)

Continuous measurement of the diffusion of radiocolloids was made possible by use of a photomultiplier tube viewing a ZnS-covered and thin walled glass capillary inside which the α-radiating particles diffuse in aqueous suspension and get adsorbed at the surface. The method is shown to yield satisfactory results for the particle size of alumina powder of known grain size distribution tagged with (Pb + Bi)-212 or Po^{210}. Po^{210} radiocolloids were found to have an average radius of about 10^{-4} cm and a specific radioactivity of about 10^{-4} whereas the values for radioactive particles generated by decay of Rn^{220} in very pure water were 10^{-6} cm and about 10^{-4}. This means that pure (carrier-free) radiocolloids could not be shown to exist. (auth)

39140 RADIOLYSIS OF WATER VAPOR BY α-RADIATION. S. Hofmann, N. Riehl, W. Rupp, and R. Sizmann (Technische Hochschule, Munich). Radiochim. Acta, 1: 203-7(Aug. 1963). (In German)

The yield of H_2 in the radiolysis of pure H_2O vapor by the 5.3-Mev α rays of a Po^{210}-source was found to be $G(H_2) = 5.9$ molecules H_2 per 100 ev of absorbed radiation energy. The yield is independent of the H_2O vapor pressure in the range of 185 Torr (65°C) to 360 Torr (79°C) within an error of ±15%. It is herewith four times higher than for α irradiation of liquid water. The α particles always remained inside the vapor space; direct boundary effects of irradiation were therefore excluded. (auth)

39141 COARSE-GRAINED INORGANIC ION EXCHANGERS WITH AN INACTIVE MATRIX. Karl-Heinz Koenig, Horst Schaefer, Fritz Hoyer, and Gerhard Rassl (Universitat, Frankfurt am Main). Radiochim. Acta, 1: 213-16 (Aug. 1963). (In German)

Coarse-grained inorganic ion exchangers were prepared by coprecipitation of adsorbing components with an inactive matrix. The resulting products were easily finished and gave column beds with small flow resistance. Their properties were demonstrated by adsorption experiments with Cs^{137}/Ba and Th^{234} (UX 1) on coprecipitates of zirconium phosphate and hypophosphate with silicic acid. As, in acidic solution, the properties of the adsorbing components are not substantially influenced by the silicic acid, such coprecipitates are very suitable for studying the fundamental properties of new inorganic ion exchangers and for applications in radiochemistry. (auth)

39142 METHOD FOR ACTIVITY DETERMINATION OF TRITIUM-LABELED POLYMERS. W. Hoffmann (Farbwerke Hoechst AG, Frankfurt am Main). Radiochim. Acta, 1: 216-17(Aug. 1963). (In German)

A method is described for the determination of tritiated polymers that are insoluble in common solvents. It is based on liquid scintillation measurement in a heterogeneous mixture with Aerosil added. (auth)

39143 THE EFFECT OF GAMMA RADIATION ON THE AVAILABILITY OF NITROGEN AND PHOSPHORUS IN SOIL. Charles F. Eno and Hugh Popenoe (Florida Agriculture Experimental Station, Gainesville). Soil Sci. Soc. Am. Proc., 27: 299-301(May-June 1963).

The effects of several levels of gamma radiation ranging from 0 to 2048 kiloroentgens on the availability of N and P from three fine sands and one peat soil were investigated. Nutrient release was measured chemically and by plant uptake. Irradiation increased the availability of N and P in soils evaluated immediately following irradiation, and after 2 weeks of incubation. This was shown by both chemical and plant uptake measurements. The release of N and P was closely related to soil type and more particularly to its organic matter content. In each case the soil containing the largest amount of organic matter showed the largest increase in extractable N and P after irradiation. An evaluation of the ammonium acetate (pH 4.8) extractable Ca, Mg, and K data indicated that there were no measurable changes

in the availability of the elements that could be directly related to irradiation of the soil. The release of N and P, in many soils, is a significant nutritional factor when plants are grown in irradiated soil. (auth)

39144 MUTUAL RADIATION GRAFTING OF STYRENE ONTO CELLULOSE ACETATE. Yoshikazu Hachihama and Hiroshi Sumitomo (Osaka Univ.). Technol. Rept. Osaka Univ., 12: 451-6(1962). (In English)

Cellulose acetate film was sealed in a glass tube that contained styrene monomer and solvent and then exposed to an 800-C Co^{60} γ-radiation source. After irradiation, the film was removed and washed with benzene, a solvent for the styrene homopolymer. The film was then extracted with acetone to remove the ungrafted cellulose acetate. The chemical composition of the graft copolymer could be roughly estimated from the differences between the amounts of material extracted and the residual copolymer. Molecular weights of polystyrene formed in different regions in the system were quite different, increasing in the following order of polymerization sites: surrounding monomer solution phase (monomer solution inside the cellulose acetate film) grafting layer. The graft copolymer isolated was much richer in the styrene component, and was soluble in tetrahydrofuran, dioxane, and dimethylformamide, but insoluble in both benzene and acetone. Polystyrene grafted on the acetyl groups and that grafted on the rest of glucose units of the stock polymer could be isolated by alkaline saponification and subsequent acetolysis. The respective amounts grafted were similar. It is suggested that grafting takes place predominantly on a specific part of the backbone polymer chain. The graft copolymer appeared to consist of the relatively small backbone chain of cellulose acetate and very few, but strikingly long, branches of polystyrene. Thus, in one experiment the number average molecular weight of cellulose acetate decreased from 5.2×10^4 initially to 4.6×10^4 after irradiation. (BBB)

39145 RADIOLYSIS OF THE IRON PENTACARBONYL AND NICKEL TETRACARBONYL. I. COMMUNICATION ON RADIOCHEMICAL INVESTIGATIONS OF METAL CARBONYLS. Helmut Barzynski and Dieter Hummel (Universität, Cologne). Z. Physik. Chem. (Frankfurt), 38: 103-9(July 1963). (In German)

The effects of Co^{60} gamma radiation on iron pentacarbonyl and nickel tetracarbonyl were investigated. Iron pentacarbonyl decomposed into CO, $Fe_2(CO)_9$, and $Fe_3(CO)_{12}$. In contrast nickel tetracarbonyl was not appreciably changed by ionizing radiation. The reactor mechanisms deduced from the experimental results are discussed. (tr-auth)

39146 ESR STUDIES ON SOME CYCLIC OLIGOMERS OF THE CAPROLACTAMS AFTER γ IRRADIATION. Werner Damerau, Guenter Lassmann, and Hans-Guenter Thom (Inst. for Medicine and Biology, Berlin). Z. Physik. Chem. (Leipzig), 223: 59-65(1963). (In German)

In the study of the effect of γ radiation on albumin systems, it is of interest to determine the mechanism of the radiation effect on the -CONH group as independently as possible of the end group effect. The -CONH grouping has, as is known, a central place since the linkage of the amino acids take place over it. In chemical reactions attachment chiefly occurs on this group. The cyclic oligomers of the caprolactams and the monomer itself are suitable as model substances for this study since there is no effect of end groups or short C side chains. The radiation effect in these oligomers is also limited to peptide formation and the almost equivalent $-CH_2$ members. The cyclic oligomers represent a connection between the previously investigated class of amino acids or linear oligopeptides and ring systems. The linear aminocaproic acids were investigated for comparison. (tr-auth)

39147 EFFECT OF IONIZING RADIATION ON HIGH POLYMERS. T. S. Nikitina, E. V. Zhuravskaya, and A. S. Kuzminsky. Russian Tracts on Advanced Mathematics and Physics, Volume XIII. New York, Gordon and Breach Science Publishers, 1963. 96p. $4.95.

Translated from the Russian by Scripta Technica, Inc.

A general definition and introduction of terms is given along with discussion on radiochemical processes in polymers and influence of radiation on various high polymeric materials. (P.C.H.)

39148 THE γ-RADIOLYSIS OF WATER VAPOUR. J. H. Baxendale and G. P. Gilbert (Univ. of Manchester, Eng.). 7p. (CONF-224-19)

From The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

Additions of small amounts of methanol, ethanol, cyclohexane, and ether to water vapor at 116°C result in large values of $G(H_2)$ when subjected to γ irradiation. $G(H_2)$ increases at first with increase of additive concentration, but in each case ultimately reaches a constant value within the range $G(H_2) = 8.0 \pm 0.7$. It was concluded that this is the value of G_H from water vapor in these conditions. The effect of oxygen on the methanol + water vapor system is to decrease $G(H_2)$ and increase $G(CH_2O)$. The latter has a value 8.5 at high oxygen concentration and is a measure of G_{OH}. The $G(H_2)$ from pure methanol vapor and pure ether vapor at 116°C is found to be 11.8 and 6.7, respectively. (auth)

39149 γ-RAY-INDUCED OXIDATION OF CARBON MONOXIDE: EVIDENCE FOR AN IONIC CHAIN-REACTION. P. G. Clay, G. R. A. Johnson, and J. M. Warman (King's Coll., Newcastle-upon-Tyne, Eng.). 10p. (CONF-224-13)

From The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

Irradiation of $CO + O_2$ mixtures with Co-60 γ rays results in the formation of CO_2 by a chain-process, yields as high as $G(CO_2) \sim 8000$ being observed under certain conditions. The reaction is inhibited by low concentrations of Hg vapor, Xe, CO_2, and CH_4. The yield of CO_2 was measured as a function of total-dose, dose-rate, gas pressure, and CO/O_2 ratio. A reaction mechanism is proposed, which is consistent with many of the experimental results; this involves as intermediates ionic species, some of which are in excited states. (auth)

39150 RADIATION INDUCED CIS-TRANS ISOMERIZATION OF 2-BUTENE IN HYDROCARBON SOLUTIONS. R. B. Cundall and P. A. Griffiths (Univ. of Nottingham, Eng.). 14p. (CONF-224-8)

From The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

The cis-trans isomerization of 2-butene induced by gamma rays in benzene solution was studied. At concentrations of 2-butene greater than 0.2 M the G values for the cis → trans and trans → cis rearrangements were 2.2 and 1.8, respectively. Iodine and ferric chloride had little effect on the rates of isomerization, nor was the yield affected by dose rate. Anthracene, naphthalene, and oxygen reduced the rate of isomerization. The isomerization in dodecane and other solvents was also examined. Possible mechanisms for the isomerization are discussed. Both positive ion and energy transfer mechanisms for the

rearrangement apply in hydrocarbon solutions. The former is most appropriate in paraffin solutions while the latter is most effective in benzene. (auth)

39151 NATURE AND REACTIVITY OF THE PRIMARY REDUCING SPECIES IN THE RADIOLYSIS OF AQUEOUS SOLUTIONS. G. Scholes, M. Simic, and J. J. Weiss (King's Coll., Newcastle-upon-Tyne, Eng.). 10p. (CONF-224-15)

From The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

A study was made of aqueous solutions of various organic solutes irradiated with Co^{60} γ rays in the presence of N_2O and CO_2, which can act as scavengers for radiation-produced reducing species. The yields of the radiation products were determined as a function of solute concentration and of pH. The results indicated the high specific reactivity of N_2O and of CO_2 towards negative polarons $(H_2O)^-$, and the conversion of these polarons into oxidizing species by reaction with N_2O. The results further support the independent formation of two reducing species, i.e., of the negative polarons and of a species reacting as hydrogen atoms. The reactivities of both these species with different organic and inorganic solutes were investigated. (auth)

39152 ROLE OF MOLECULAR MOTIONS IN REACTIONS OF RADICALS PRODUCED BY IRRADIATION AND TRAPPED IN SOLID MATRICES. R. Bensasson, M. Durup, A. Dworkin, M. Magat, R. Marx, and H. Szwarc (Faculte des Sciences, Paris). 10p. (CONF-224-16)

From The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

Experimental results are reported concerning bimolecular reactions in organic solids induced by ionizing radiations. In particular radical recombinations, oxidations, and polymerization reactions were examined. Attempts were made to give an explanation of the most striking features. (auth)

39153 PHYSICAL INTERACTIONS IN THE RADIOLYSIS OF LIQUID AND GASEOUS HYDROCARBONS. P. J. Dyne, J. Denhartog, and D. R. Smith (Atomic Energy of Canada Ltd., Chalk River, Ont.). 12p. (CONF-224-17)

From The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

A physical interaction occurs in the radiolysis of liquid alkane hydrocarbon mixtures which may lead to a much larger amount of decomposition of one component than is to be expected from its mole fraction. This is shown by measurements of the isotopic composition of hydrogen evolved from mixtures of cyclohexane-d_{12} with other alkane hydrocarbons. The additives carbon tetrachloride, cyclohexene, p-benzoquinone, and benzene change the extent of decomposition of the cyclohexane-d_{12} in a similar fashion. It was concluded that they reduce the total hydrogen yield from alkanes by the same physical mechanism and not by hydrogen-atom scavenging. This physical interaction is absent in the vapor phase, showing that there are major differences in mechanism between liquid-phase and vapor-phase radiolysis of hydrocarbons. (auth)

39154 ELECTRONIC SPECTRA AND RELATED IONIC EFFECTS IN GAMMA-IRRADIATED ORGANIC GLASSY SOLIDS. W. H. Hamill, J. P. Guarino, M. R. Ronayne, and J. A. Ward (Univ. of Notre Dame, Ind.). 9p. (CONF-224-18)

From The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

Gamma irradiation at 77°K of organic glassy solids which contain solutes RX or M provides evidence for the formation of R and X^- by dissociative electron attachment, M^- by simple electron attachment, and M^+ by charge exchange with appropriate components of the matrix. Benzyl chloride and naphthalene illustrate the two types of solute. Detection in all cases was based upon electronic absorption spectra. Failure to observe M^+ in ethanol and other polar media indicated efficient formation of such protonated species as ROH_2^+. Benzyl radicals were observed in glassed ethanol containing benzyl acetate following gamma irradiation and equivalent yields of acetic acid were found in the subsequently thawed samples. It appears that ionic processes may play a major role in radiation chemistry. (auth)

39155 POLYFUNCTIONAL SIMPLE MOLECULES: CHEMICAL INTEREST. Joseph J. Weiss (Univ. of Durham, Newcastle-upon-Tyne, Eng.). 13p. (CONF-81-4)

From Conference on Basic Mechanisms in the Radiation Chemistry of Aqueous Media, Gatlinburg, Tenn., May 1963.

A review is presented on the nature of radioinduced chemically active species and their energy yields. Energy yields, reactions of olefinic and conjugated double bonds, reactions of simple aliphatic molecules with negative polarons, and reactions in the presence of CO_2, N_2O, and CO are discussed. (P.C.H.)

39156 PHASE CHANGE AND ENERGY TRANSFER EFFECTS IN THE RADIATION CHEMISTRY OF ORGANIC SUBSTANCES. E. Collinson, J. J. Conlay, and F. S. Dainton (Univ. of Leeds, Eng.). 17p. (CONF-224-14)

From The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

$G(-S)$ values, where S = $FeCl_3$ or I_2 or DPPH for solutions of S in various organic solvents, were measured at different temperatures in the range −196-30°C. For all systems in the liquid or glassy solid phases, [S] diminishes linearly with dose, and $G(-S)$ is largely independent of [S] and temperature (provided the phase is not changed), being larger in the liquid than the glass. Crystalline solid solutions fall into two categories. Type-A systems, comprising solutions of $FeCl_3$ in diethyl ether or 1,4-dioxan, or DPPH in benzene or diphenyl ether, are similar to glasses. Type-B systems, comprising solutions of $FeCl_3$ in benzene, diphenyl ether, diphenyl methane, and phenetole (crystalline state only), and I_2 in diphenyl ether, give steeply curved [S]-dose graphs and $G(-S)_0$ increases proportionately with increase of [S], the slope of this line being larger the lower the temperature. Thus values of $G(-S)_0$ for the solid phase may be much larger than $G(-S)$ for the liquid or glassy phases (in benzene at −196° this factor can be as large as 30), and there is a sudden increase of $G(-S)_0$ on freezing. Reasons are given for believing that the reaction occurs while the system is solid and that in class-B systems the radiation induces formation of excitons corresponding to the molecular state $^1B_{2u}$ (for benzene), which are propagated over distances of 50-100 Å. Interaction of these with solutes whose absorption spectrum overlaps the exciton spectrum causes chemical change of the solutes. Class-A crystals cannot form excitons in the appropriate spectral range. That crystallinity is essential for class-B behavior is shown by the grossly disparate results for the systems that show class-B behavior when crystalline and class-A behavior, at the same temperature and solute concentration, when they are in either the supercooled liquid or glassy states. Other observations are recorded and explained on the same hypothesis. (auth)

39157 LET DEPENDENCE OF G VALUES AS A GUIDE IN DETERMINING THE PRIMARY MECHANISMS OF RADIOLYSIS. LET EFFECTS IN CYCLOHEXENE. W. G. Burns and J. A. Winter (Atomic Energy Research Establishment, Harwell, Berks, Eng.). 12p. (CONF-224-12)

From The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

The yields of hydrogen, C_2 hydrocarbons, cyclohexane, C_{12} products, and total polymer were measured for fast electrons and 1.5 Mev α particles at comparable dose-rates, and some of the products were also measured for γ rays and protons. Parameters varied were dose, dose-rate, temperature and, for protons, particle energy from 0.7 to 1.8 ev. $G(H_2)$ increased from 1.26 for lightly ionizing radiations to 2.95 for 1.5 Mev α particles, while $G(C_6H_{12})$ decreased from 0.85 to 0.3, and G(2,2'-bicyclohexenyl) decreased from 1.4 for fast electrons to 0.4 for 1.5 Mev α particles. Under the conditions of high dose-rate, where the C_6 radicals are likely to undergo only intercombination and disproportionation reactions, the increase in $G(H_2)$ is too large compared with the decrease in $G(C_6H_{12})$ to be accounted for solely by competition between $H\cdot + C_6H_{10} \rightarrow C_6H_{11}\cdot$ and $H\cdot + H\cdot \rightarrow H_2$. The main trends of the results for individual products may be accounted for by competition between the reactions of excited molecules: $C_6H_{10}^* + C_6H_{10} \rightarrow H_2$ + unsaturated substances, $C_6H_{10}^* \rightarrow H\cdot + C_6H_9\cdot$, and $C_6H_{10}^* \rightarrow C_6H_{10}$ (deactivation), the hydrogen atoms subsequently undergoing either intercombination or abstraction and addition reactions with cyclohexene. The total polymer G value decreased with increasing LET, and this is thought to be due to the greater probability of ion-electron recombination compared with ion-molecule reactions as the LET is increased. (auth)

39158 NEUTRAL FRAGMENTS FROM HYDROCARBONS UNDER ELECTRON IMPACT. D. Beck (Universitat, Freiburg i. B). 10p. (CONF-224-21)

From The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

Information about the physicochemical stage of events immediately after the sample molecule has been excited by a primary particle and then starts to react spontaneously or as a result of collisions is presented. The results may be useful in judging the nature and products of the primary reactions of a few hydrocarbons and their relative importance. The conditions are, however, different from those generally encountered in radiation chemical investigations. Therefore a detailed description of the technique and its implications is given. (P.C.H.)

39159 SCAVENGER STUDIES IN THE RADIOLYSIS OF AQUEOUS FERRICYANIDE SOLUTIONS AT HIGH pH. G. Hughes and C. Willis (Univ. of Liverpool). 10p. (CONF-224-11)

From The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

A study was made of the radioinduced reduction of alkaline, aqueous solutions of potassium ferricyanide. From the effect of methanol on the reduction yield, G(OH) and the sum, $G(H) + 2G(H_2O_2)$, were obtained. Two separate processes for the production of molecular hydrogen peroxide are indicated from results obtained with added potassium ferrocyanide. The reactivity of the OH radical is consistent with its being present as O^-. This may be produced either by ionization of OH or from some other precursor. (auth)

39160 THE ROLE OF UNSATURATED PRODUCTS IN THE RADIOLYSIS OF METHANE. R. W. Hummel (Atomic Energy Research Establishment, Wantage, Berks, Eng.). 8p. (CONF-224-10)

From The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

The radiolysis of gaseous CH_4 with 4 Mev electrons gives much larger yields of C_2H_4 than previously reported, in addition to significant amounts of C_2H_2. The effects of scavengers, and of pressure and dose-rate changes, indicate the reaction of CH_2 with CH_4 to form $C_2H_6^*$, which is either collisionally deactivated or decomposes to form C_2H_4 or C_2H_2. The higher yields of these products at low conversions, low pressures, and high dose rates is compared with gas-discharge work. (auth)

39161 RADIOLYTIC EXCHANGE OF CARBON-14 BETWEEN CARBON MONOXIDE AND CARBON DIOXIDE. D. A. Dominey and T. F. Palmer (Atomic Energy Research Establishment, Harwell, Berks, Eng.). 12p. (CONF-224-9)

From The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

The exchange of C^{14} between labeled CO and CO_2 of normal isotopic composition was studied by using the Harwell nuclear reactor BEPO and a source of γ radiation. The measured G value for reactor radiation is 3.0 (±0.3) and for γ radiation 4.2 (±0.5). The rate of formation of CO_2^{14} is increased by the presence of oxygen and decreased by the presence of nitrogen dioxide. Analysis of the results shows that the mechanism of the reaction cannot be explained in terms of reactions of oxygen atoms. A mechanism is suggested for oxidation of CO to CO_2 by an active oxygen species, which is produced as a result of a reaction between oxygen and CO_2^+. The same process can be used to explain the stability of CO_2 under ionizing radiation. (auth)

39162 ELECTRON MULTIPLICATION IN ARGON AS A GUIDE TO MECHANISM IN THE RADIATION CHEMISTRY OF n-BUTANE. E. Collinson, J. F. J. Todd, and F. Wilkinson (Univ. of Leeds, Eng.). 13p. (CONF-224-20)

From The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., Sept. 1963.

Chemical changes in n-butane were induced by electron multiplication in argon. Under appropriate conditions, breakdown occurs as a result of transfer of energy from argon atoms in metastable and other excited states to butane molecules, giving ions; and interaction between butane molecules and electrons to give mainly excited states. Variation of the experimental conditions leads to a changing importance of the relative contributions of both, and the products, which were analyzed by means of vapor-phase chromatography, may be classed as of principally ionic or non-ionic origin. (auth)

39163 PROCESS FOR THE IRRADIATION OF CHEMICAL SYSTEMS. Frederic Francois Albert Braconier, Roger Fernand Robert Coekelbergs, and Pierre Alexandre Gosselain (to Societe Belge de l'Azote et des Produits Chimiques du Marly). British Patent 936,210. Sept. 4, 1963. Filed Mar. 21, 1960.

A process for effecting reactions in gaseous or liquid chemical systems by gamma irradiation is patented. The irradiation is carried out in the presence of a microporous substance having a specific surface area of at least 100 m^2/gm. The microporous substance may be activated C, alumina, silica gel, or a molecular sieve, and it is capable

of catalyzing the reaction only when irradiated with γ rays. The radiocatalytic effect may be increased by dispersing metallic salts or other compounds such as UO_2 in and/or on the microporous substance. Examples of reactions that may be effected by the process and the preferred radiocatalyst for each reaction are: polymerization of ethylene, alumina with UO_2; telomerization of ethylene, activated C; dimerization of methane, silica gel with UO_2; decomposition of nitrous oxide, silica gel or alumina; fixation of N in the air, silica gel or alumina; and synthesis of ammonia from N and H, alumina. (M.P.G.)

39164 RADIOACTIVE POLYMERS. Gordon Dwight Brindell and David Wesley Marshall (to Continental Oil Co.). British Patent 937,314. May 22, 1963. Priority date Aug. 8, 1960, United States.

Radioactive polymers and methods of preparing them by polymerizing unsaturated hydrocarbons in the presence of tritium are patented. An unsaturated hydrocarbon, such as an olefin or a conjugated diolefin, is mixed with tritium and added to a polymerization catalyst suspended in an inert solvent. The reaction may be carried out at a temperature from room temperature to 200°C. A wide range of polymerization catalysts may be used, including metal organo-transition metal halide catalysts. Triethylaluminum–titanium tetrachloride and n-amyl sodium–titanium tetrachloride are specifically recommended catalyst systems. The level of radioactivity in the finished polymer can be adjusted easily by the quantity of tritium mixed with the unsaturated hydrocarbon and H. (M.P.G.)

Raw Materials and Feed Materials

39165 MILLIKEN'S TWO-STAGE SULPHURIC ACID LEACHING PROCESS FOR URANIUM ORES. N. Robb, V. Opratko, and L. S. Price. Can. Mining Met. Bull., 56: 476-9(June 1963).

Laboratory and plant testing and details of the two-stage H_2SO_4 leaching process for uranium ores are discussed. The effects of density, temperature, and time on the rate of reaction were studied. (Rev. Metal Lit., 20: No. 9, Sept. 1963)

39166 ENRICHED URANIUM PROCESSING. Finis S. Patton, John M. Googin, and William L. Griffith (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). International Series of Monographs on Nuclear Energy. Division IX. Chemical Engineering. Volume 2. Oxford, Pergamon Press, 1962. 290p. 70/-. (TID-15922)

A book is presented as a guide and reference on the processing of enriched uranium in industry. The emphasis is on practical applications and on basic principles and operations. Process chemical, metallurgical, and ceramics operations are discussed in detail. The health, safety, and economic factors in each operation are reviewed. (D.L.C.)

39167 PROGRESS IN THE RESEARCH UPON THE RECOVERY OF OTHER VALUABLE METALS FROM URANIUM ORES. Karol Pinkas and Danuta Szymańska (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). 15p. (CONF-207-5). (In Polish)

From Second Yugoslavian Polish Symposium on Uranium Technology and Metallurgy, Zakopane, Poland, Sept. 1963.

Investigations concerning the simultaneous recovery of uranium and molybdenum from carbonaceous ores were carried out. The ore was leached in the presence of oxidizing agents by means of sulfuric acid and alkaline solution. The optimum leaching conditions were determined; they assure the recovery of about 90% U and 80% Mo in the acid leaching and about 90% U and 90% Mo in the alkaline leaching. On the basis of these results, direct underground leaching of the ore in the case of alkaline solutions seems to be possible. The possibilities of the recovery of titanium and gallium from other domestic uranium ores were also investigated. (auth)

39168 PROGRESSES IN DOMAIN OF THE CHLORINATION OF THE URANIUM RAW-MATERIALS. Jaroslaw Zienkiewicz (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). 22p. (CONF-207-6). (In Polish)

From Second Yugoslavian Polish Symposium on Uranium Technology and Metallurgy, Zakopane, Poland, Sept. 1963.

In order to explain the chlorination of uranium, studies were made on the system (UO_x,Cl_2,R) under variable conditions. Applying the original radiometric method and the method of synthesis, the influence of the reactants was proved and the characteristic of the products was obtained. By the chlorination of natural uranium oxides, similar results were obtained. The material value-balance was elaborated. (P.C.H.)

39169 RECENT PROGRESS IN THE FIELD OF URANIUM ORE PROCESSING. Tadeusz Adamski, Juliusz Borysowski, Stefania Domanus, Józef Panas, and Rafal Wlodarski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). 32p. (CONF-207-4). (In Polish)

From Second Yugoslavian Polish Symposium on Uranium Technology and Metallurgy, Zakopane, Poland, Sept. 1963.

A review is given of recent investigations in uranium ore technology. A new, highly efficient milling process, which has a large range of application, is described. Experiments were made on leaching of uranium ores using acids and carbonates. Sedimentation was performed on neutralized uranium pulps with Polish starchy focculent on a laboratory and semi-technical scale. A scheme of the sedimentation apparatus is given. The influence of the methods of uranium concentrate precipitation on its physical properties is described and a method is given for the separation of phosphates included in it. Experiments on the decontamination of uranium effluents are also presented. (P.C.H.)

39170 CERTAIN PROBLEMS IN PURIFICATION AND TECHNOLOGY OF URANIUM SALTS AND METALLIC URANIUM. Franciszek Mucha, Bohdan Kalinowski, Rafal Wlodarski, and Zygmunt Grzybowski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). 28p. (CONF-207-7). (In Polish)

Experiments carried out on uranium compound technology, especially the processes leading from uranyl nitrate to metallic uranium, are described. Progress was gained in improvement of the purity degree of the obtained products. The influence of some factors (raw material, apparatus material, some technological operations, and construction details) on the purity of the products, especially on purity of uranium tetrafluoride is discussed. Changes in the accepted method of the calciothermic reduction of uranium tetrafluoride are discussed, as a result of a passing from the subatmospheric pressure process to the above-atmospheric pressure process and as a result of the security of nuclear purity metallic uranium. The elaborated technology of the sintered fluorite crucible from natural fluorite is also described. The trial valuation of the nuclear purity of the obtained uranium compounds was performed on the base of the summary impurity calculation. (P.C.H.)

39171 METHOD FOR PRODUCING URANIUM HEXAFLUORIDE. J. B. Adams, J. C. Bresee, L. M. Ferris, and Ch. D. Scott (to United States Atomic Energy Commission). German Patent 1,148,533. May 16, 1963. Priority date Apr. 24, 1959, United States.

The method described is concerned with the production or uranium hexafluoride by conversion of UF_4 with oxygen. The method comprises the steps of introducing dry UF_4 and dry oxygen containing gas into a zone of high turbulence of UO_2F_2, the concentration of the UF_4 within the said zone remaining below 25 weight %. The temperature of the zone of high turbulence is maintained at about 600 to 900°C, and the UF_6 produced in this run is recovered. Two examples are described in detail. A description of the apparatus is given. (NPO)

Separation Processes

Refer also to abstracts 39301, 40386, 40387, 40388, 40389, and 40390.

39172 (DPSPU-62-30-12A) PROCEDURAL CONTROL OVER RADIOCHEMICAL SEPARATION PROCESSES AT THE SAVANNAH RIVER PLANT. Walter E. Egan and Arthur S. Mowry (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). Aug. 1962. Contract AT(07-2)-1. 16p. (CONF-175-2)

From American Chemical Society 142nd National Meeting, Atlantic City, Sept. 1962.

A discussion is presented of the application of written procedures at the Savannah River Plant to the problem of controlling the actions of personnel in radiochemical processing plants. The organization of the Savannah River Plant is described briefly. (D.L.C.)

39173 (ORNL-TM-670) RESULTS OF SHAKEDOWN TESTS ON THE KILOROD SOLVENT EXTRACTION SYSTEM. M. G. Baillie, E. C. Moncrief, and J. L. Matherne (Oak Ridge National Lab., Tenn.). Sept. 6, 1963. Contract [W-7405-eng-26]. 8p.

The Kilorod solvent extraction system was operated under flowsheet conditions. Only trace levels (~0.001 g/l) of uranium-233 were present in the feed, but satisfactory uranium recovery was achieved. Decontamination factors for Th and gross gamma rays were $\sim 1 \times 10^3$ and 100 to 450, respectively, for an 18 hr period of steady-state, two-column operation. Equipment performance was generally satisfactory. (auth)

39174 (ORNL-TM-671) ADDITIONAL SHAKEDOWN TEST INFORMATION ON THE KILOROD SOLVENT EXTRACTION SYSTEM. M. G. Baillie, E. C. Moncrief, and J. L. Matherne (Oak Ridge National Lab., Tenn.). Sept. 6, 1963. Contract [W-7405-eng-26]. 10p.

Additional runs [CT-3 and CT-4 in a continuing testing program of the Kilorod solvent extraction system are reported. As in previous runs, only trace levels of U^{233} were present in the feed. Thorium and gross γ decontamination factors were 2.5×10^4 and 130, and 3.4×10^3 and 100 for a steady state period of three column and two column operation, respectively. Uranium losses to the HAW stream during the runs were 16 and 6%, respectively, though these figures may be meaningless at the low uranium concentration of these runs. Significant quantities of aluminum were found in the product of the three columns run. A solution was sought to this problem by improving B column control. The product from the two column run was satisfactory. Equipment performance during the runs was generally satisfactory after some modifications. (auth)

39175 (ORNL-TM-673) RESULTS OF INTERMEDIATE ACTIVITY TESTS OF THE KILOROD SOLVENT EXTRACTION SYSTEM (RUNS HR-1 AND HR-2). M. G. Baillie, E. C. Moncrief, and J. L. Matherne (Oak Ridge National Lab., Tenn.). Sept. 6, 1963. Contract [W-7405-eng-26]. 11p.

Two test runs (HR-1 and HR-2) of the solvent extraction system were made, using conditions identical to those proposed for full operating runs. Approximately 600 grams of uranium was charged to the feed tank, compared with 5 kg which will be charged during full level runs. This resulted in a feed solution of about 0.6 grams per liter compared with 5 grams per liter at full level. Thorium and gross γ decontamination factors in the final product were 1.7×10^3 and 600, and 1.9×10^3 and >100 respectively, for runs HR-1 and HR-2. Uranium losses totalled 0.5% and 0.3% respectively for the two runs. Aluminum nitrate from residual contamination in the product tank rendered the product from run HR-1 unsuitable for the sol-gel process, but the product from run HR-2 was acceptable. (auth)

39176 (ORNL-TM-676) KILOROD PROGRAM: CHANGES AND ADDITIONS TO THE NUCLEAR SAFETY REVIEW FOR BLDG. 3019 SOLVENT EXTRACTION PLANT. M. G. Baillie (Oak Ridge National Lab., Tenn.). Sept. 6, 1963. Contract W-7405-eng-26. 9p.

Changes in the uranium purification reference flowsheet are summarized, and their effect on the original criticality review is presented. Some additional criticality control means are given, where cold operation has shown the initial proposals to be questionable. A review of nuclear safety for the dissolving of massive U-233 metal pieces from the Jezebel assembly is also given. (auth)

39177 (ORNL-3452) CHEMICAL TECHNOLOGY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 31, 1963. (Oak Ridge National Lab., Tenn.). Sept. 20, 1963. Contract W-7405-eng-26. 293p.

Progress in chemical technology is reported under 24 topics. Separate abstracts were prepared for each topic. (M.C.G.)

39178 (ORNL-3452(p.1-25)) POWER REACTOR FUEL PROCESSING. (Oak Ridge National Lab., Tenn.).

The preparation of uranium and thorium carbides and their subsequent hydrolysis in water and other aqueous reagents were studied. Nearly single-phase uranium monocarbide (UC) was prepared by an arc-melting method. Preparation of uranium dicarbide, however, resulted in the preparation of $UC_{1.85}$, not stoichiometric UC_2. Hydrolysis at 80°C of as-cast uranium-carbon alloys with compositions between UC and $UC_{1.85}$ yielded complex mixtures of gaseous hydrocarbons, hydrogen, and a solid tetravalent oxide. Waxes were formed when the alloy contained either U_2C_3 or $UC_{1.85}$. As the C/U ratio in the carbide increased from 1 to 1.85, the methane concentration in the gas decreased, and the amounts of hydrogen, C_2- to C_8-hydrocarbons, and wax increased. Thorium dicarbide had a composition of $ThC_{1.85}$. Hydrolysis products of ThC and water were the same as those found for UC. Thorium dicarbide when contacted with water produced more alkynes and less wax than those obtained with $UC_{1.85}$. Soluble organic species, primarily acids, were produced during the dissolution of uranium carbides in nitric acid. The UO_2 slurry obtained by hydrolysis of UC was easily dissolved in boiling 8M HNO_3. Nineteen hot-cell demonstrations of the Sulfex process for decladding stainless-steel-clad UO_2 fuel in boiling 4M H_2SO_4 were made with prototype Yankee Atomic Reactor fuel specimens irradiated up to 28,200 Mwd/ton. The exposed uranium dioxide was washed with

water and dissolved in boiling 4M HNO_3 to provide a feed suitable for a modified Purex solvent extraction process. Stainless steel dissolution rates averaged 2 mg min^{-1} cm^{-2}, which were comparable to those obtained with unirradiated specimens. Soluble losses of uranium and plutonium to the decladding solution averaged about 0.05%. The decladding solutions required filtration to remove undissolved scale and uranium dioxide fines. The dissolution rates of high-density UO_2, PuO_2, and UO_2-PuO_2 pellets were determined as a function of acid, nitrate, fluoride, and aluminum concentrations, with and without various oxidizing agents. The dissolution rate (in mg min^{-1} cm^{-2}) of UO_2 pellets of 95% theoretical density was defined by the equation, log (rate) = 2.1 log (NO_3) − 0.68. The dissolution rate of PuO_2 pellets, 90% of theoretical density, in 14M HNO_3 − 0.1M HF was 2.1 mg min^{-1} cm^{-2}; without fluoride it was 0.006 mg min^{-1} cm^{-2}. The addition of 3 moles of aluminum per mole of fluoride eliminated the rate-increasing effect of the fluoride. The dissolution rate of pellets prepared from coprecipitated PuO_2-UO_2 may be calculated from the rates of the pure components. Ionic plutonium (but not plutonium polymer) was successfully adsorbed from nitrate solutions on zirconium phosphate or zirconium phosphate silicate. A chemical flowsheet was developed for the reprocessing of U^{233} for fuel recycle by extraction with di-sec-butylphenyl phosphonate (DSBPP). The factor for U^{233} decontamination from daughters of U^{232} was greater than 100, and the nitrate-to-uranium ratio in the product was less than 2.3. Rate studies indicated that a 4-kg sphere of uranium metal will dissolve in 1.5M $Th(NO_3)_4$ − 4M HNO_3 in about 68 hr. In laboratory studies on the adsorption of protactinium from nitrate solutions, unfired Vycor was loaded to greater than 10 mg of Pa^{231} per gram of glass. In one test, about 80% of the protactinium was recovered at a concentration equivalent to 120 times the feed concentration by eluting with 0.5M oxalic acid. The remainder of the protactinium was recovered at lower concentrations. Decontamination factors of protactinium from thorium, uranium, ruthenium, zirconium-niobium, and total rare earths of 6300, 1.59×10^4, 40×10^3, 3, and 5.8×10^5, respectively, were obtained in tracer experiments. The presence of 2.5 moles of aluminum per mole of fluoride reduced the fluoride corrosion of the glass by a factor of 50. The use of 7.5 moles of aluminum per mole of fluoride increased the adsorption distribution coefficient to that of fluoride-free solutions. The distribution coefficient of Pa^{233} between laboratory-prepared silica gel and nitric acid was three times that of unfired Vycor and more than five times that of commerical silica gel. Protactinium-containing synthetic dissolver and solvent extraction feed solutions were prepared to determine the long-term solution stability of protactinium. These solutions showed no change other than a ±10% scatter in the analytical values after standing one month at room temperature in plastic containers, or a ±6% scatter after contacting type 347 stainless steel (2 cm^2 per milliliter of solution) for one week. The combining ratio of tributyl phosphate (TBP) to thorium nitrate was measured and is believed to be 4. The extraction of uranium from acid-deficient aluminum nitrate by a given concentration of TBP may be expressed solely as a function of the pH of the solution. Over the range 0.5 to 4M HF, the uranium distribution coefficient with 30% TBP remains constant at 1 when the nitrate-to-fluoride ratio is 3.5. The distribution coefficient of protactinium tracer between fluoride-free 5M HNO_3 and 30% TBP is 4. The protactinium is completely complexed and is not extracted when the solution is 0.02M in HF. In corrosion studies on aqueous processes, no material tested was satisfactorily resistant to HNO_3−HF mixtures at all temperatures and compositions. Corronel 230 was the most generally acceptable material tested. Aluminum corroded at very low rates in mixed acid when the HNO_3 was ≧15.6M and HF was ≧1M, but rates became catastrophic at lower HNO_3 concentrations. Corronel was also the most satisfactory material tested in a reprocessing cycle consisting of oxidation of fluoride-contaminated graphite at 800°C followed by digestion in 5M HNO_3. Rates on Corronel were about 0.1 mil/month for 22 cycles vs 19.6, 7.5, 9, and 8 mils/month, respectively, for type 304L stainless steel, Carpenter 20, Haynes 25, and Nichrome V. Prefilmed titanium exposed in nitric-fluoboric acid solutions containing Cr(VI) employed for zirconium dissolution corroded at overall rates of 4.14 to 7.75 mils/month after defilming; after about 70 hr of exposure, pitting occurred. A shear-and leach apparatus, which consists of a 250-ton, horizontally actuated prototype shear, rotary-drum conveyor-feeder, and rotary-drum leacher, was successfully operated. A series of shear-leach runs were made in which UO_2 was leached from sections of unirradiated ORNL Mark I, 36-tube prototype fuel assemblies with 7 to 8M HNO_3 as the dissolvent. The results obtained in these tests showed that leaching of UO_2 from sheared sections of stainless steel tubing in a rotary-drum leacher is feasible. Bench-scale batch studies on the leaching of UO_2-ThO_2 from sheared sections of stainless-steel-clad fuel, in Thorex dissolvent, show that suspension of fines is essential to good dissolution. Complete particle-size-distribution data were obtained for sheared sections of ORNL Mark I stainless-steel-clad porcelain, UO_2, and UO_2-ThO_2 and for Zircaloy-2-clad UO_2. The amounts of particles discharged from both UO_2 and ThO_2-UO_2 fuel rods are about equal, slightly more being discharged from ThO_2-UO_2 cores. An investigation of remote maintenance of the shear was initiated. Extraction tools were designed and built for remote removal and installation of the gags, fixed-blade holder, and the moving blade in the shear housing, using the feed mechanism hydraulic cylinders as the moving force. Stainless-steel-clad and Zircaloy-2-clad UO_2 fuel specimens, irradiated to 16,000 and 17,000 Mwd/ton, respectively, appeared to have the same particle-size distribution of the UO_2 fines as for unirradiated fuel. In a continuation of evaluation of methods for safely handling sodium- and NaK-bonded fuels, design studies and limited experiments were made of various methods for removing inert end adapters from fuel clusters that use spiral-wound wire on the fuel rods as spacers. (M.C.G.)

39179 (ORNL-3452(p.26-50)) FLUORIDE VOLATILITY PROCESSING. (Oak Ridge National Lab., Tenn.).

The decontamination of the equipment in cell 1 of the Volatility Pilot Plant was demonstrated following a six-run series on 5- to 6.5-yr decayed zirconium-uranium alloy fuel. The decontamination program, as developed in laboratory studies, included a simulated-fuel dissolution run, a molten-salt flush, and extensive cleaning of process equipment with water and circulating and static decontaminating solutions [0.34M ammonium oxalate, 0.03 to 0.10M $Al(NO_3)_3$ − 0.10 to 0.01M HNO_3, and 5-1-1 to 5-2-2 wt % $NaOH-H_2O_2$ − sodium tartrate]. Ammonium fluoborate was added as a nuclear poison to the initial ammonium oxalate wash. The general activity levels in cell 1 were 30 to 60 millirems/hr, and residual equipment activity was sufficiently low after decontamination to permit direct maintenance. However, nickel weld filler metal 61 (INCO-61) in the L-nickel fluorinator was severely attacked. Metallographic examination of samples of L-nickel removed from

the lower part of the fluorinator revealed attack on the base metal at the rate of 0.38 mil/hr based on 57.7 hr of fluorine exposure time, including the decontamination procedure. During examination following aqueous decontamination, a crack was found near the bottom of the hydrofluorinator. Following decontamination of the equipment, the pilot plant was modified to improve product purity by the addition of a magnesium fluoride bed for technetium and neptunium removal, allow convenient recycle of off-specification product, provide a solids rod-out device in the hydrofluorinator off-gas line, and add the shielding needed for future higher radiation levels. After the modifications, five runs with cold and irradiated zirconium-uranium alloy were completed. Alloy dissolution rates ranged from 2.0 to 2.9 kg/hr for three cold runs, during which HF utilization efficiencies per pass through the dissolver were 24 to 34%. Greater dissolution rates and HF utilization efficiencies were obtained during the processing of 13-month- and 6-month-decayed alloy. The product recovery operations were successful, although HF contamination of the product was appreciable (up to 30 wt %) during cold runs. Conversely, the product from the first hot run was free from HF, while the product from the second run had 0.5% HF contamination. Average fluorine utilization efficiencies were 5% during cold runs and 14 and 7% during the runs with 13-month- and 6-month-decayed alloy. Nonrecoverable uranium losses, mainly to the waste salt, during all fluorinations were less than 0.46%. Overall process decontamination factors ranged from greater than 10^8 to nearly 10^{11} for volatile fission products (Sb^{125}, Te, Ru^{106}, and Nb^{95}), and from greater than 10^9 to greater than 10^{10} for nonvolatile fission products (Zr^{95}, Sr^{90}, and Cs^{137}) during the run on 6-month-decayed fuel. Generally lower DF's were obtained during the run on 13-month-decayed fuel. Trace quantities of volatile fission products reached the MgF_2 trap during both runs, probably due to entrainment rather than to absorber breakthrough since Cs^{137} was also collected. The MgF_2 trap was effective for Tc^{99} removal during the runs but less effective for Np^{237} removal. The performance of pilot-plant equipment was generally satisfactory during all runs. All difficulties encountered were relatively minor, and in each case it was possible to continue operations or to repair or modify the equipment. Results of the metallographic examination of five groups of corrosion rods exposed in the pilot-plant fluorinator were received during the year. Nickel filler metal 61 (INCO-61), E-nickel, nickel–5 Fe, nickel–1 Al, INOR-8, and HyMu 80 all showed significantly improved performance over L-nickel and thus are possible materials of construction for a fluorination vessel. Plutonium hexafluoride was fluorinated from a 31-24-45 mole % LiF–NaF–ZrF_4 melt containing about 1000 ppm plutonium, at rates similar to those obtained for a concentration of 2 ppm. The volatilization rate has a first-order dependence on concentration, with reaction half-times of about 5.3 hr at 500°C and 3.0 hr at 600°C. Neither violent salt agitation nor intermittent additions of UF_4 increased the rate of PuF_6 volatilization. Material balances of 95 to 100% were obtained in all the fluorination tests conducted with about 1000 ppm of plutonium and 55 mg of total plutonium present. In addition to the CaF_2 previously studied, high-surface-area LiF and MgF_2 both showed high effectiveness for trapping volatilized PuF_6. Observations made in the course of attempting to prepare TeF_6, a volatile fission product fluoride present in processing short-decayed fuel, indicated that it is readily reduced by nickel at less than 300°C. Thus, in the fused-salt fluorination step much of this fission product is retained on the relatively cool upper walls of the fluorination reactor. In studying the absorption of TeF_6 in 10% aqueous KOH, a 12% TeF_6 mixture in fluorine was passed through two 20-in.-long × 1 in.-dia columns, in series, packed with 0.25-in. Alundum Berl saddles with an absorption of 46, 68, and 67% of the tellurium, respectively, at 25, 50, and 70°C. Single-vessel hydrofluorination-fluorination and salt recycle are being evaluated on an engineering scale. Dissolution experiments with Zircaloy-2 and zirconium-uranium alloy elements indicated that salt recycle has no significant effects on rate and also showed that filtration and/or settling steps for salt purification are not required. Corrosion rates measured during a series of single-vessel dissolutions and fluorinations in INOR-8 vessels, on either a laboratory or engineering scale, were not significantly different from the sum of the rates noted when the two process steps were conducted in separate vessels. The alloys HyMu 80 (Alloy 79-4), Ni–5 Fe, and Ni–1 Al showed some possibility of providing corrosion rates lower than those for INOR-8, the material of construction for the present pilot-plant hydrofluorinator. The data on the sorption of UF_6 from a flowing stream of UF_6–N_2 by beds of NaF pellets in the temperature range 29 to 100°C and at UF_6 concentrations of 0.57 to 8.5 mole % UF_6 were correlated by use of a mathematical model that took into account the effect of temperature, UF_6 concentration, gas flow rate, and pellet characteristics. Based on the results previously reported for Alloy 79-4, an attempt was made to determine whether this composition was optimum for hydrofluorination conditions. Somewhat inconclusive results were obtained by exposing INOR-8, HyMu 80, and experimental alloys to 50.5–37.5–12.5 mole % NaF–LiF–BeF_2 and to 37.5–37.5–25 mole % NaF–LiF–ZrF_4. These tests were done with HF, but without zirconium dissolution. At 650°C, HyMu 80, Ni–10 Mo, and Ni–10 Mo–5 Fe corroded less than INOR-8. In studies comparing the 36.9–27.0–27.0–9.1 mole % NaF–LiF–ZrF_4–BeF_2 mixture at 500°C with the highly corrosive 50.5–37.0–12.5 mole % NaF–LiF–BeF_2 mixture of 650°C, the former was found to be only slightly corrosive. Initial Zircaloy-2 dissolution rates were significantly lower than the rates caused by the NaF–LiF–BeF_2 melt. (M.C.G.)

39180 (ORNL-3452(p.51-96)) WASTE TREATMENT AND DISPOSAL. (Oak Ridge National Lab., Tenn.).

Eleven engineering-scale tests of pot calcination were made with simulated waste of the following types: TBP-25, five tests; Purex and formaldehyde-treated waste, 1965 (FTW-65), six tests. Feeding the calciner pot by gravity feed (gravity head of 10 ft) was a satisfactory alternative to pump feeding directly from the evaporator. A cyclone mercury trap operating at 150 to 200°C in the calciner off-gas line retained only 10 to 17% of the mercury. The distribution of ruthenium in the closed loop of the evaporator-calciner system was determined in a test with Purex FTW-65 waste with nonradioactive ruthenium (0.09 g/liter). Only 0.03% of the ruthenium escaped from the evaporator, and 10% remained in the evaporator heel. Average feed rates to the loop system were 15 to 26 liters/hr for TBP-25 waste and 26 to 68 liters/hr for Purex FTW-65 waste, depending on the presence or absence of organic in the waste and the degree to which the pot had been filled with calcined solids. Sulfate was easily retained in the calciner pot by adding calcium nitrate solution to produce a 10% stoichiometric excess of calcium and sodium over the sulfate. Two types of permanent seals were developed for

calcination pots, the reliability of remote operation and equipment maintenance was demonstrated, and heat transfer data were obtained under simulated process conditions. A pilot plant to demonstrate the pot calcination of radioactive wastes is being designed. Fixation experiments on high-sulfate Purex waste produced nonglassy, apparently insoluble products that retained as much as 98% of the sulfate. Darex wastes, fixed as glassy solids or as ceramics, were leached at rates of about 1.3×10^{-6} and 4×10^{-3} g cm^{-2} day^{-1} for a glass containing 15.3% waste oxides and a ceramic containing 25% waste oxides respectively. Corrosion studies showed that type 304L stainless steel is a satisfactory material of construction for both the fixation pot and the pot head. Methods were developed for measuring the thermal conductivity of powders, and the variation of k was correlated with the theoretical density of the material. Equipment is being constructed for semi-pilot-plant-scale demonstration of the pot-calcination process. Both calcination and glass formation will be tested, and the stability of the products will be determined. Seven additional runs were completed in the 600-gph pilot plant for testing the scavenging-precipitation ion exchange process for waste-water processing. Decontamination factors for Sr^{90} and Cs^{137} ranged from 2000 to 12,000 and from 77 to 3400, respectively, in 12 demonstration runs. In all but two runs the average activity of the process effluent was less than 3% of the MPC_w values for all isotopes with respect to continuous occupational exposure. The presence of hexametaphosphate in the waste-water feed decreased hardness precipitation (calcium and magnesium), thereby causing a premature breakthrough of Sr^{90} to the ion exchange column effluent in two of the runs. Foam separation was studied as a method for decontaminating process waste water, and both one- and two-step processes are being developed. The two-step process employs a slowly agitated, upflow sludge column and a countercurrent foam column. Calcium is precipitated as the carbonate and is retained in the sludge column; the clear effluent is fed to the foam column. Laboratory-scale experiments with spiked tap water gave overall strontium decontamination factors of 1000 to greater than 10,000; decontamination factors across the foam column were in excess of 100. Initial results from experiments with ORNL process waste water gave strontium decontamination factors across the foam column in excess of 15, 20, and 200. In the two-step process calcium is precipitated as the orthophosphate in a small mixer, and solution and solids are fed to the foam column, where both flotation and foam separation occur. Strontium decontamination factors with simulated and actual ORNL waste water gave, respectively, values of 1000 for simulated waste and 200 to 300 with ORNL waste. Engineering studies showed HTU_x values as low as 1 cm in a 6-in.-dia foam separation column for liquid flows up to 100 gal ft^{-2} hr^{-1} when conditions were selected to give uniformly sized bubbles and to avoid channeling. A study undertaken to evaluate the economics and safety associated with alternative methods of waste management in a nuclear power industry showed that the costs for the interim storage of solidified wastes for periods of 1 to 30 yr ranged from 0.0015 to 0.0048 mill/kwh(e) for calcined, acid Purex and Thorex wastes, and 0.0018 to 0.0063 mill/kwh(e) for calcined, reacidified Purex and Thorex wastes. The interim storage of acid wastes as solids costs less than storage of the same wastes as liquids, but the reverse is true for neutralized wastes. The effects of fission product removal on total waste-management costs, which are the sums of the costs of interim storage, pot calcination, shipping, and final disposal in salt mines, were estimated according to optimistic expectations of future processes for separating the fission products. The cost of managing wastes that are 90 to 99% depleted in fission products is about 70% as much as the cost of managing wastes with no fission products removed. The difference, about $400 per metric ton of uranium processed, is not enough to pay for the separation and handling of fission products. (M.C.G.)

39181 (ORNL-3452(p.96-133)) TRANSURANIUM ELEMENT PROCESSING. (Oak Ridge National Lab., Tenn.).

The Transuranium Processing Plant (TRU) and High Flux Isotope Reactor (HFIR) are being built to produce gram quantities of many of the heavier actinide elements for research purposes. Target material for HFIR irradiation is prepared from plutonium-aluminum alloy irradiated to a greater than 99.9% burnup of Pu^{239}. The irradiations and the recovery of the residual plutonium (Pu^{242}) by conventional solvent extraction or anion exchange procedures are being done at Savannah River. Recovery of Am^{243} and Cm^{244} in the raffinate by either anion exchange or tertiary amine extraction from neutral nitrate salts and the final purification of Am^{243} and Cm^{244} is by the Tramex (Transuranium amine extraction) Process. Irradiated HFIR targets are processed by separation of the actinides from fission products by the Tramex Process. Subsequently, the actinides are split into an americium-curium fraction and a transcurium fraction by extraction with di-sec-butylphenyl phosphonate. Berkelium is isolated by extraction of Bk^{4+} with dialkylphosphate from nitric acid solution, and the individual elements in the group Cf–Es–Fm are separated by chromatographic elution from an organic anion exchange resin. (M.C.G.)

39182 (ORNL-3452(p.134-43)) CURIUM PROCESSING. (Oak Ridge National Lab., Tenn.).

The recovery of 30 g of plutonium and 4 g of transuranium elements from highly irradiated Pu–Al alloy fuel rods was completed in a pilot-plant study of flowsheets featuring anion exchange separation methods. The process was conducted according to a flowsheet which includes dissolution of the fuel rods in 6M HNO_3 catalyzed with 0.05M Hg^{2+} and 0.03M F^-, coagulation of the soluble silica by digestion at 80° with 10 ppm of gelatin, clarification, valence adjustment of the plutonium to the tetravalent state, nitric acid concentration adjustment to 7.0M, followed by sorption on Permutit SK ion exchange resin, scrubbing sorbed aluminum and fission products from the resin with 7.0M HNO_3 – 0.01M F^- followed by elution of the plutonium with 0.7M H^+. The plutonium was further purified by readjustment of the plutonium valence to 4 and the acid concentration to 7.0M and repeating the ion exchange step. Further processing of the aluminum-bearing wastes from the first ion exchange cycle to recover the transuranium element included evaporation of the waste until the boiling temperature reached 140°C, acid and aluminum concentration adjustment, clarification, and sorption of the rare earths and transuranium elements on Dowex 1-X10 ion exchange resin, scrubbing sorbed aluminum and light fission products from the bed with 8M $LiNO_3$, and elution of the rare earth fraction containing the transuranium elements with 0.7M HNO_3. Plutonium product suitable as feed for the isotopic separation process was recovered. The plutonium assayed 75% Pu^{242}. Gross decontamination from fission products averaged 2×10^5. The rare earth fraction contained the transuranium elements decontaminated from aluminum by a factor of 70 and from light fission products by a factor of 10. High recovery of the product hinged on the effective washing of the filter cake during the clarifi-

cation step; as much as 25 to 30% of the transuranium elements was retained in the cake under some operating conditions. Colloidal $Al(OH)_3$ present in ion exchange feeds in which the acid deficiency exceeded 1.0 N interfered with the mechanical operation of the ion exchange system. The high-level solvent extraction development facility for the Transuranium Program is being modified to supply multigram quantities of Cm^{242} free of fission products for the fabrication of heat sources such as SNAP 13, SNAP 11, and others, and Surveyor lunar probes. The first gram quantities of Am^{243} and Cm^{244} from the plutonium irradiation will be recovered in this facility, using fission product Am–Cm concentrates isolated at Savannah River. Cm^{242} has a specific heat generation rate of 120 w/g and decays with a 162.5-day half life. Engineering calculations for irradiating gram quantities of Am^{241} in the Oak Ridge Research Reactor were completed. They are based on an average perturbed thermal neutron flux of 3.0×10^{14}, a peak-to-average thermal flux ratio of 1.2, and an irradiation time of 50 days. If a 100% release of the gaseous fission products is assumed, the maximum stress in the aluminum capsule is 500 psi. (M.C.G.)

39183 (ORNL-3452(p.144-66)) THORIUM FUEL-CYCLE DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

The sol-gel process was developed to convert thorium nitrate to dense ThO_2 particles, and uranyl and thorium nitrates to uranium-thorium oxide particles suitable for loading into fuel tubes by vibratory compaction. The major emphasis in the development of the sol-gel process was to optimize it for the demonstration of the full-scale preparation of 10 kg of $U^{233}O_2-ThO_2$ (uranium/thorium weight ratio, 3/97) per day. This will be done in the Kilorod Facility, a pilot plant with a capacity of ten fuel rods per day. The facility is being used to prepare 1000 fuel rods clad with Zircaloy-2 for zero-power criticality experiments at the Brookhaven National Laboratory. Engineering equipment was designed and successfully operated for each step of the sol-gel process at full scale, by using U^{238} nitrate as a stand-in. About 200 kg of $U^{238}O_2-ThO_2$ was prepared for vibratory-compaction studies. Five runs with U^{238} nitrate were made in the Kilorod Facility with only minor difficulties. The steps in the sol-gel process, including denitration of thorium nitrate, dispersion of the denitrated thorium to a sol, formation of the gel by evaporation, and firing to dense oxide particles having properties suitable for vibratory compaction, were shown to be flexible. The steam denitration of thorium nitrate solution gave thoria that was equally as dispersible as the oxide from thorium nitrate crystals. In the preparation of the sol of a 3% UO_2-ThO_2, oxide concentrations up to 5M gave satisfactory gels when evaporated. Sol-gel thoria and 3% UO_2-ThO_2 spheres about 0.5 cm in diameter were prepared that had attrition rates as low as 0.005%/hr in a standard spouted-bed test. All analytical and photographic evidence indicated that sol-gel uranium-thorium oxide products containing up to 10 mole % uranium are homogeneous solids, probably solid solutions. Particles have densities between 99 and 99.8% of the theoretical value. The closed porosity, measuring less than 1% of the volume of the solid is uniformly distributed throughout in about equal-sized pores. When optimally sized, these oxides can be vibratorily packed to (90 ± 1)% of theoretical density in fuel tubes from $\frac{1}{4}$ to $\frac{1}{2}$ in. in diameter. Sol-gel oxides are free from contaminants that parasitically capture neutrons. The O/U ratios (calculated on the assumption that the O/Th ratio = 2) varied from 2.02 to 2.5, depending on the furnace atmosphere in which the gels were calcined. The volume of gas released by heating to 1200°C in vacuum varied from 0.002 to 0.4 std cm^3/g and depended on the atmosphere in which the oxide was calcined and the grinding applied after calcination. It was shown to be possible to hold the gas evolution, particularly hydrogen, oxygen, and water, to a value low enough to prevent excessive corrosion of the Zircaloy-2 cladding while the element is in service. Thirty-two irradiation-test capsules were fabricated by vibratory compaction: 27 from enriched-uranium sol-gel oxide and 5 from arc-fused oxide. These were or are being irradiated in the NRX, MTR, and ORR. The in-pile tests were completed on 18 capsules, and the accumulated results show the sol-gel oxide to be a satisfactory reactor fuel. For the 16 capsules that were irradiated in the NRX and in the MTR with burnups of 5000 to 17,000 Mwd per metric ton of Th + U, linear heat ratings from 25,000 to 45,000 Btu hr^{-1} ft^{-1}, a clad temperature of about 200°F, and average fuel temperatures of 2000 to 2500°F, no significant dimensional changes in the capsules nor evidences of sintering of fuel were observed. Cold and low-activity-level runs were completed in the Kilorod Facility. Thorium and gross-gamma decontamination factors of 1100 to 25,000 and 100 to 500, respectively, were measured during shakedown tests of the solvent extraction system used to purify the U^{233} feed for the program. Satisfactory sol-gel feed (NO_3^-/U ratio less than 2.5) was obtained, as well as low uranium losses (less than 0.07% to the extraction-column waste). A 4-kg piece of U^{233} metal was dissolved in 40 hr. Sixty-five kilograms of specification-grade thoria-natural urania was prepared in the sol-gel line during six shakedown runs. This material was successfully processed through powder conditioning and vibratory compacting into the rods. The density of the packed powder was 9.0 g/cm^3. A maximum hand-exposure case was evaluated in which a single operator performed all operations in the Kilorod Facility over a two-week period. A maximum gamma dose to hands of 1000 millirems was estimated to be received during the second week of the operating cycle. Carbon, having a particle size of 90 Å and a specific surface area of 670 m^2/g, was dispersed in sols of thoria or uranium-thorium oxide at carbon-to-metal mole ratios of 4.3 to 6.8 to form stable, mixed sols. By evaporation of these sols to gels, and calcination of the gels, complete conversion to the dicarbides was obtained at a temperature as low as 1580°C. Conversions were obtained in times as short as 1 hr and 15 min at 1750 to 1800°C. Studies of the kinetics of carburization of thoria indicated the reaction to be first order or pseudo first order with respect to ThO_2. Arrhenius plots were straight lines between 1500 and 1800°C, and apparent activation energies ranged from 110 to 170 kcal per mole of ThO_2. Initial experiments in forming uranium–thorium oxide–carbon mixed sols to spheres of 100 to 250 μ diameter in carbon tetrachloride and setting them to gels by the addition of isopropyl alcohol gave a high yield of spheres in the desirable size range. Title I design of the Thorium–Uranium Fuel-Cycle Development Facility was completed. The facility will consist of four large operating cells having a total inside area of 2120 ft^2, plus two supporting cells and a glove maintenance room, together with the necessary operating areas and other facilities. Shielding is of normal concrete 5.5 ft thick. The cells are equipped with window liners on 8-ft centers, half of which are plugged and half equipped with zinc bromide viewing windows. In-cell cranes and electromechanical arms are provided to facilitate equipment maintenance, removal, and replacement by remote means. Process equipment is provided for the sol-gel vibratory-compaction method of fabricating fuel rods. This system is to be de-

signed such that it can fabricate rods ranging in diameter from 0.25 to 0.75 in. and in length from 3 to 10 ft. Changes from one rod configuration to another can be accomplished by replacing various fixtures on the basic machines. The equipment for this process will occupy only about half the cell space, leaving the remaining space available for another process equipment line. (M.C.G.)

39184 (ORNL-3452(p.166-7)) CHEMISTRY OF LANTHANIDES AND TRANSPLUTONIUM ELEMENTS. (Oak Ridge National Lab., Tenn.).

Study of the separations chemistry of the lanthanides and the transplutonium elements is continuing, with two main objectives: finding an efficient actinide-lanthanide separation that does not require use of chloride and developing separations for the individual transplutonium elements. Extraction of Am(III) was greater than that of Am(VI) by factors greater than 10^4 with D2EHPA from dilute HNO_3; up to 100 with trioctylphosphine oxide from lithium nitrate; and up to 30 with tributyl phosphate (TBP) from sodium nitrate. Extraction by D2EHPA should be applicable to the separation of curium from americium as Am(VI), since Cm(III) is usually still more extractable than Am(III). (auth)

39185 (ORNL-3452(p.168-88)) SOLVENT EXTRACTION TECHNOLOGY. (Oak Ridge National Lab., Tenn.).

Batch equilibration tests with both aged and fresh Purex plant solutions showed that the aged but not the fresh plant solutions contain zirconium-niobium species highly extractable by the hydrocarbon diluents used with amines and other extractants. The amounts of zirconium-niobium species extractable from the aged solutions were sufficient to account for the low decontamination previously obtained when aged plant solution was used in continuous countercurrent demonstration of the flowsheet. Batch cascade tests with fresh plant solution showed separation and decontamination factors high enough for use in the projected purification process. Continued studies on amine extraction of nitrato nitrosylruthenium complexes showed extractions by a quaternary amine to be qualitatively similar to those previously reported with a tertiary amine, but extractions by a primary amine to be considerably different, increasing continuously with increasing nitric acid concentration from 1 to 10M. Extraction coefficients were about 0.001, 0.1, and 1 at 1M HNO_3, and 0.05, 0.006, and 0.02 at 10M HNO_3 with (respectively) primary, tertiary, and quaternary at about 0.25M in toluene. Data were obtained for the extraction with amines of twenty different metals from HCl and LiCl–0.2M HCl solutions over the range 0.5 to 10M total chloride. With few exceptions, the extraction power of the amines for the various metals varied in the order: Aliquat 336 (quaternary amine) > Alamine 336 (tertiary amine) > Amberlite LA-1 (secondary amine) > Primene JM (primary amine). For most metals the extraction coefficients increased with an increase in chloride concentration. Extraction of uranium(VI) and niobium from hydrofluoric acid by amines decreased with increased hydrofluoric acid concentration. The primary amine extracted uranium best, and the tertiary amine extracted niobium best. Extractions of both metals were poorest with the secondary amine. The stability of Amsco 125-82 (aliphatic hydrocarbon) against nitric acid was improved by pretreatment with concentrated sulfuric acid or by preliminary nitric acid degradation followed by treatment with sulfuric acid. Use with tributyl phosphate of diethylbenzenes, butylbenzene, or trimethylbenzenes, rather than aliphatic diluents, gave improved performance with regard to radiation stability, uranium extraction power, and separation of uranium from fission products. The isomers of diethylbenzene varied in stability against side-chain degradation by nitric acid, and in order of decreasing stability were: meta > ortho >> para. Favorable separations of alkali metals were obtained by extracting with substituted phenols from alkaline solutions. With 4-sec-butyl-2(α-methylbenzyl)phenol (BAMBP), the order of extractability was Cs > Rb > K > Na > Li, and separation factors were ~20 for both cesium/rubidium and rubidium/potassium. Combining a small concentration of di(2-ethylhexyl)phosphoric acid with BAMBP greatly enhanced alkali metal extractions from neutral or slightly acidic liquors where extraction with BAMBP alone is inappreciable. Extractions were also synergized by combining dinonylnaphthalenesulfonic acid, dodecylphosphoric acid, or Neo-Tridecanoic acid with phenols. The phenol extraction (Phenex) process was applied to the recovery of cesium from ores and its separation from other alkali metals. The cesium in pollucite ore was solubilized by roasting the ore with Na_2CO_3–NaCl at 800°C and leaching with water. Greater than 99% of the cesium was recovered from this solution by extracting with 1M 4-sec-butyl-2(α-methylbenzyl)phenol (BAMBP) in diisopropylbenzene and stripping with hydrochloric acid. Overall decontamination factors (leach liquor to strip product) for cesium were 230 from Rb, 610 from K, 16,000 from Na, >10 from Li, and >3000 from Si. Preliminary tests showed the potential utility of tertiary amines for recovery and purification of phosphoric acid from the highly contaminated wet-process acid produced in the fertilizer industry. Water-stripping the amine yields a product more than 1.5M in H_3PO_4 and almost free of iron and aluminum. Quaternary ammonium compounds extracted niobium and tantalum from alkaline solutions. Niobium was extracted preferentially in some tests with pure solutions, but no appreciable separation of the elements was obtained in tests with practicable ore liquors. Solutions of Na_2CO_3, NaOH, $(NH_4)_2CO_3$, K_2CO_3, chloride salts, and nitrate salts were effective stripping agents. A number of amides, covering a range of structures, were examined with regard to their extraction of uranium, thorium, and several other solutes from nitric acid solutions. In comparison with tributyl phosphate (TBP), the N,N-dialkylamides extract in the same manner, are somewhat weaker uranium extractants, but have potential for considerably greater selectivity. The amides resemble TBP in synergistically enhancing uranium extraction by di(2-ethylhexyl)phosphoric acid. Branched-chain amides showed much lower extractions but higher indicated selectivity for uranium. Extraction was low for uranium and thorium from hydrochloric and sulfuric acid solutions, and for strontium and cesium from nitrate solutions. A systematic survey was started of cation-exchange extraction by high-molecular-weight carboxylic acids. Hydroxamic acids showed potential for extraction of zirconium, niobium, hafnium, and strontium. The available acids decomposed when exposed to nitric acid or alkaline solutions but appeared stable in extraction from hydrochloric acid, suggesting usefulness in nonoxidizing acid systems. A bicyclic or "cage-structure" phosphate ester, the bicyclic phosphate of 1,1,1-trimethylolnonane, showed high extraction power for thorium and high selectivity for thorium over uranium. Alkaline earth extraction by di(2-ethylhexyl)phosphate in benzene was studied. A suitable model was developed for strontium extraction when the extractant ranged from the acid form to the 50% salt form. The choice of diluent affects strontium extraction by shifting the pH of maximum extraction, and in some cases by synergistic enhancement. Formation constants were eval-

uated for the thorium trisulfate and tetrasulfate anionic complexes on the basis of amine extraction equilibrium data. Continued transfer-rate measurements of tagged sulfate from amine solution to aqueous sulfate solution, with uranium absent, present and extracting, or already at equilibrium, gave evidence that both neutral complex transfer and ion transfer contribute to the uranium transfer, the former predominating in extraction from low-sulfate solutions, where little of the uranyl ion is complexed, and the latter becoming important at higher sulfate concentrations, where most of the uranium exists in anionic complexes. Direct precise measurement of diluent vapor-pressure differences showed increasing polymerization of di(2-ethylhexyl) phosphate solutions in benzene as the proportion of salt form increased. The same technique was used to measure the activity coefficients of triphenylmethane in benzene. The activity coefficients of azobenzene and of tri-n-octylamine were determined by isopiestic balancing. Pulsed columns show promise in that the stage heights for uranium extraction by tributyl phosphate at a flow ratio of 100:1 was only 2 to 3 times that at a more conventional ratio of 5:1. Knowledge of the maximum and minimum hydraulic pressure at the base of a pulsed column is needed for design of the pulser and external piping. The variation of orifice coefficients (calculated from maximum and minimum pressure) of nozzle plates with pulse frequency and direction of flow was determined to be not significantly different from that for conventional sieve plates. (M.C.G.)

39186 (ORNL-3452(p.189-94)) FISSION PRODUCT RECOVERY. (Oak Ridge National Lab., Tenn.).

Continued study confirmed the utility of the Phenex process for recovering cesium from alkaline Purex wastes by extracting with substituted phenols and stripping with dilute acid. Of a large number of phenols screened, best performance was given by 4-sec-butyl-2(α-methylbenzyl) phenol (BAMBP) and 4-chloro-2-benzylphenol (Santophen 1). In a batch countercurrent test with Santophen-1 in diisopropylbenzene diluent, >99.7% of the cesium was recovered from simulated Purex 1WW waste (tartrate complexed and adjusted to pH 12.3) in six extraction and two scrub stages. The extract was stripped with 0.1M HNO_3 to give a product solution with ~5 g of cesium per liter. The overall cesium/sodium decontamination factor for the experiment was $\sim 6 \times 10^4$. The process was also applied to the treatment of alkaline liquors produced by sorbing cesium from acid wastes with ammonium molybdophosphate (AMP) and dissolving the AMP in caustic. The di(2-ethylhexyl)phosphoric acid (D2EHPA) extraction process for recovering strontium and mixed rare earths gives efficient separation of yttrium from the rare earths in the nitric acid stripping cycle. Batch countercurrent tests indicated that the yttrium content of the rare-earths product would be <2% of the amount in the original waste solution. Comparison of tartrate and citrate as complexing agents for the Purex 1WW feed showed that results are strongly dependent on feed-adjustment procedures. More efficient extractions of strontium and rare earths were obtained from tartrate-complexed than with citrate-complexed feeds. Efficiencies in the extraction of zirconium-niobium from Purex 1WW solution with D2EHPA and stripping with oxalic acid were greatly improved by increasing the temperature. In a batch countercurrent test, most of the acid, iron, zirconium-niobium, and ruthenium were extracted with a primary amine (Primene JM) from simulated Purex waste while extracting only ~5% of the cerium. More than 98% of the cerium was then extracted from the solution with Primene JM, leaving a raffinate that would be highly amenable to treatment for strontium and cesium recovery. (auth)

39187 (ORNL-3452(p.194-6)) URANIUM PROCESSING. (Oak Ridge National Lab., Tenn.).

In studies on the column adsorption of Ra^{226} from simulated, neutralized waste streams from uranium mills, the capacities to 5% radium breakthrough were ~2000 column volumes for clinoptilolite (natural zeolite) and 6000 column volumes for Decalso (synthetic zeolite). Ammonium nitrate was an efficient eluting agent. The uranium extraction power of the N-benzyl secondary amines is sufficiently strong that they can be applied to the treatment of chloride-containing sulfate liquors of the type produced in plants that use the salt-roast acid-leach process for uranium-vanadium recovery. (auth)

39188 (ORNL-3452(p.196-9)) THORIUM RECOVERY FROM GRANITIC ROCKS. (Oak Ridge National Lab., Tenn.).

Three drill-core samples to depths of 500 to 600 ft in the Conway granite formations in New Hampshire showed uniform thorium concentration and thorium leachability with depth. The thorium reserve in the outer 600 ft of the main Conway mass was estimated at 21 million tons. The uranium reserve in the rock is probably a fourth to a fifth of the thorium reserve. Process studies indicate that about two-thirds of the thorium and a smaller fraction of the uranium can be recovered by an acid leach–solvent extraction flowsheet for an average cost of less than $75 per pound of thorium plus uranium. Thorite, huttonite, and zircon were identified as the major carriers of thorium in Conway granite. (auth)

39189 (ORNL-3452(p.199-202)) PROTACTINIUM CHEMISTRY. (Oak Ridge National Lab., Tenn.).

The investigation of the chemistry of protactinium was concerned primarily with extraction of Pa(V) from sulfuric acid solutions by organic amine solutions and by anion exchange resins. The extractability of Pa(V) from sulfuric acid is qualitatively related to the base strength of the amine; extraction coefficients for different amines vary over several orders of magnitude. An observed marked decrease in the extraction of protactinium with increasing aqueous acidity may be due at least partly to changes in the composition of the organic phase, particularly the decrease in sulfate ion concentration, as well as to changes in the aqueous protactinium complex. Extraction coefficients obtained with Dowex 1 resin and with dilute trilaurylamine, at conditions giving relatively low extraction, increase very rapidly with the aqueous protactinium concentrations above about 10^5 counts min^{-1} ml^{-1} (Pa^{231}) in 2.5M H_2SO_4. These observations are consistent with a reversible polymerization of Pa(V) in one or both phases, with both the polymer and the simpler species being extracted, and the polymer being more extractable. (auth)

39190 (ORNL-3452(p.203-9)) EFFECTS OF REACTOR IRRADIATION ON ThO_2. (Oak Ridge National Lab., Tenn.).

Thoria pellet and powder preparations irradiated in D_2O and dry in the LITR to exposures of 2.5×10^{18} fissions/gram were examined to determine irradiation effects. The preparations included P-82 thoria pellets; sintered thoria compacts; shaped, arc-fused thoria pellets; sol-gel thoria particles; Houdry thoria spheres (44 to 74 μ); arc-fused thoria fragments (44 to 74 μ); and 1600°C-fired thoria powder (DT-46). The purpose of the experiment was to determine the influence of the method of preparation and

the physical condition of the product on the irradiation effects and on effects associated with the presence of water. Radiation effects were evaluated in terms of visual examination, material balances, wear tests, impact fracture tests, and x-ray and metallographic examination. Principal attention was paid to the P-82 pellets. The P-82 pellets irradiated under D_2O and dry showed minor weight losses but did not appear to suffer structural damage. A portion of the pellets irradiated in the vapor phase, however, showed a significant weight loss as well as considerable surface and structural damage. Wear tests showed that the pellets irradiated under D_2O and dry had enhanced attrition resistance. The surface of the P-82 pellets was found to contain an aluminum/thorium weight ratio of 0.08, in contrast with an average aluminum content of 0.02% for whole pellets, which may account for the stability of the P-82 pellet under irradiation. The thoria pellets prepared by a method different from that for the P-82 pellets suffered considerable damage upon being irradiated in D_2O, despite their higher initial density. Those irradiated dry appeared undamaged. The arc-fused pellets and sol-gel-prepared particles irradiated under D_2O and dry did not appear on visual inspection to be significantly damaged by the irradiation. No gross changes were observed in the Houdry spheres and in the ground, arc-fused materials. Wet-irradiated 1600°-fired thoria powder was transformed into a porous plug contaminated with corrosion products; the dry-irradiated material has formed a chalky plug. X-ray diffraction measurements on the P-82, arc-fused, and sol-gel-prepared materials indicated that relatively little change had occurred as a result of the irradiation, indicative of the marked resistance of cubic structures to radiation damage. Polished sections at low magnification of the unirradiated and irradiated P-82 and arc-fused materials were similar. The irradiated sol-gel-prepared material exhibited extensive fracturing. At high magnification the polished and etched sections of all irradiated and unirradiated materials were similar. (auth)

39191 (ORNL-3452(p.210) RADIATION EFFECTS ON CATALYSTS. (Oak Ridge National Lab., Tenn.).

Attempts to alter the catalytic activity of $MgSO_4$ and $MgSO_4-Na_2SO_4$ by the addition of trace impurities failed, providing further evidence that the previously reported effects were caused by the presence of radioactive sulfur. The overall reaction order for the dehydration of cyclohexanol on these catalysts was found to be 1. (auth)

39192 (ORNL-3452(p.211-15)) HIGH-TEMPERATURE CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Design of the high-temperature, high-pressure spectrophotometer system by a subcontractor was completed. The prototype absorption cell is undergoing testing. A spectrophotometer, Cary model 14 CMR, was installed and equipped with the previously constructed digital data output system. It is operable with solutions at temperatures up to 95°C. Valve and support problems encountered with the miniature circulating-loop system, designed for operation with liquids up to 170°C and 200 psi, were solved. An autoclave and facility designed for the accurate measurement of liquid densities at high temperatures and high pressures was built. It should be possible to determine densities of solutions at 370 to 371°C within a maximum error of 0.6% with this system. The error will be less at lower temperatures. A computer program for the analysis of spectrophotometric absorption data for dynamic multicomponent systems was written and tested. Concentration-time data for each component of the reacting system can be obtained to within a relative error of ±0.1% over the entire course of the reaction. Output may be tabulated and/or plotted on the Calcomp graphical plotter. A set of computer programs and subroutines was written for the least-squares convolution smoothing of the noise and random fluctuations from digitized spectral data obtained from the spectrophotometer digital data output system. The fitting is done for each point over a 3- to 15-point range, utilizing a cubic function. The smoothed-data output may be in the form of tables, punched cards, or Calcomp graphical plotting. (auth)

39193 (ORNL-3452(p.215-18)) MECHANISMS OF SEPARATIONS PROCESSES. (Oak Ridge National Lab., Tenn.).

For the purpose of developing a mathematical description of extraction of nitric acid and uranyl nitrate from aqueous solutions by tributyl phosphate (TBP)–hydrocarbon diluent solutions, activities of water, nitric acid, uranyl nitrate, and TBP are being obtained by transpirational vapor-pressure techniques. The activity of water and the stoichiometric, molecular, and ionic activity coefficients of nitric acid were obtained for 0 to 100% acid by combining new data with literature data. Measured vapor pressures of TBP over water–nitric acid–TBP solutions were used to calculate a value of 1.75 for the equilibrium constant, K/γ_{TN}, for extraction of nitric acid by TBP. Water and nitric acid activities over the three-component system water–nitric acid–uranyl nitrate were measured. From these data the activities of uranyl nitrate will be calculated. (auth)

39194 (ORNL-3452(p.218-20)) ION EXCHANGE. (Oak Ridge National Lab., Tenn.).

The anion exchange resin, Dowex 1 (50 to 100 mesh) in the hydroxyl form, lost more than 90% of its strong-base capacity in a flowing-water system after an exposure of 1.3×10^9 r in a Co^{60} gamma-irradiation source, about half the dose reported in the literature for this resin in a static system for a comparable loss of capacity. Analysis of data from the irradiation of Dowex 50W cation exchange resin indicated that degradation occurs, initially, by cleavage of the active sulfonate groups and is followed by the breakup of the resin matrix into water-soluble products and small, noncentrifugable particles with a molecular weight of several million. Citrate at pH 2.5 (usually citrate is used at higher pH's) was evaluated as a complexor of impurity cations in the ion exchange recovery of rare earths and strontium fission products from radioactive wastes like Hanford Purex 1WW. Experimental distribution coefficient data, obtained from Dowex 50W-X8 (100- to 200-mesh) cation resin pre-equilibrated at pH 2.5 and waste solution treated with 1.5 moles of citrate per mole of combined Al^{3+}, Fe^{3+}, and Cr^{3+} (impurity cations), indicated that bulk trivalent cation impurities were effectively complexed and remained in solution; resin capacity for strontium and rare earths increased as waste acidity was lowered by dilution; and at a reasonable waste dilution factor of 20, separation factors were favorable, being: K_d^{Sr}/K_d^{Sr}, >200; K_d^{Ce}/K_d^{Fe}, >600; and K_d^{Ce}/K_d^{Sr}, ~3. (auth)

39195 (ORNL-3452(p.221-8)) CHEMICAL ENGINEERING RESEARCH. (Oak Ridge National Lab., Tenn.).

Eight geometrically distinct designs of the stacked-clone contactor, a high-throughput, low-holdup solvent extraction device, were tested for capacity and stage efficiency with uranyl nitrate–1M sodium nitrate–18% TBP–Amsco. Within each design, the effects of the diameter and length of the vortex finder were studied, as was the area of the feed port. With Mark I, a ¾-in.-dia conical design, the

effects of different underflow baffling and underflow chamber volumes were also studied. The original design, the Mark I contactor, gave combined flow capacities of 2.0 liters/min at 70% efficiency. The Mark XI contactor, the latest design of a series, gave capacities of 4.5 liters/min at 60 to 70% efficiency. This corresponds to a retention time of both phases per theoretical stage of about 4 sec. The Mark XI design represents a useful and practical prototype high-speed contactor for radiochemical processing. Studies of the effect of ionizing radiation on coalescence rates in liquid-liquid solvent extraction systems were undertaken. Fast protons, alpha particles, or fission fragments may be produced in the vicinity of the interdrop membrane by the neutron irradiation of hydrogen, Li^6, or U^{235} in the aqueous phase. Preliminary experiments show no effect of recoil protons on the coalescence of water drops in benzene, in agreement with theory. In studies of the dynamics of contacting gases and liquids in packed columns, experiments were conducted on an air-CO_2-water system using ceramic Raschig rings. Both direct sinusoidal and pulse forcing of the entering gas composition were used, and good agreement was obtained between the two perturbation methods in terms of the resulting amplitude ratios and phase shifts. A simplified theoretical dynamic model indicated that dynamic behavior is primarily influenced by the absorption factor, the number of transfer units, and the time required for the phases to traverse one transfer unit. Further experimental data must be obtained, including measurements on the distribution of velocities, before mathematical models for packed columns can be evaluated. (auth)

39196 (ORNL-3452(p.229-32)) GAS-COOLED REACTOR COOLANT PURIFICATION. (Oak Ridge National Lab., Tenn.).

The investigation of the kinetics of the oxidation of small amounts of H_2, CO, and CH_4 (impurities) in a flowing stream of helium by fixed beds of porous pellets of copper oxide is continuing. Two forms of copper oxide were tested: porous pellets made by compaction, and a mixture of powdered copper oxide, alumina, and silica, extruded into pellets. The oxidation of the impurities is a proposed first step in the purification of the helium before its use as a coolant for the Gas-Cooled Reactor. Two types of CuO were tested in the following range of conditions: temperature, 400 to 600°C; pressure, 10.2 to 300 atm; mass flow rate of the gas, 0.0058 to 0.050 g cm^{-2} sec^{-1}; and contaminant concentration, 0.0008 to 1.21 vol %. The rate controlling factors for the three contaminants are: mass transfer of the H_2 or CO from the bulk gas stream to the CuO reaction site, and reaction surface in the CuO particles for the oxidation of the CH_4. Computer solutions of the mathematical models were made, and correlation of the experimental and model-predicted results will be the basis for reactor design. An experimental investigation was started on the characterization of aerosols by determining particle-size distribution and concentration in gas streams by means of a light-scattering technique. The detecting cell for this device was made, and instruments are being procured. An aerosol generator was developed for use in calibrating the detector. (auth)

39197 (ORNL-3452(p.232-3)) EQUIPMENT DECONTAMINATION STUDIES. (Oak Ridge National Lab., Tenn.).

Laboratory tests showed that stainless steel blowers and piping exposed to contaminated helium at the operating temperatures of the Experimental Gas-Cooled Reactor can probably be adequately decontaminated, without damage, by hot oxalic acid solutions containing fluoride and hydrogen peroxide. These mixtures were superior to many others for decontaminating, for dissolving oxide films, and for brightening the surfaces of heated stainless steels. The search for improved methods is continuing. (auth)

39198 (ORNL-3452(p.233-5)) FUEL SHIPPING STUDIES. (Oak Ridge National Lab., Tenn.).

Experimental and cost studies were made on the shipping of irradiated reactor fuels to a fuel-processing plant. The experimental work involved the dropping of 1.4- and 6-ton model casks from heights up to 28 ft in order to evaluate a section of the proposed AEC regulations on fuel shipping. Flat drops from 15 ft resulted in little or no damage, but corner and "piston" drops from this height did result in minor damage. Thus it appears that, except for the piston-impact provisions, the regulations can be satisfactorily met by careful cask design. Shipping cost studies indicated that, for a domestic-fuel-discharge rate of 3 tons of natural uranium per day, the truck shipping cost for a 2350-mile round trip with a 25-ton cask would be about $1.30 per kilogram of uranium for an irradiation level of 8500 Mwd/ton. Rail costs are higher by almost a factor of 2. The shipping of the same fuel from Italy to southern California by chartered boat was estimated to cost only $1.25 per kilogram of uranium. (auth)

39199 (ORNL-3452(p.235-9)) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIVES (PROJECT COACH). (Oak Ridge National Lab., Tenn.).

A flowsheet was developed for the recovery of the few grams of transplutonium isotopes (to be produced in the Coach nuclear detonation) from the 10,000 to 35,000 tons of salt in which it will be dispersed. In this flowsheet the mined and crushed salt is dissolved in 2.5 lb of water per pound of salt; and the insoluble material, containing 99% of the transplutonic isotopes and fission products, is separated from the brine. The separated insolubles are dissolved in nitric or hydrochloric acid. Oxalic acid is then added to the acid leach to precipitate about 1% of the dissolved calcium; the calcium oxalate, which carries the transplutonics quantitatively, is separated and probably dried for shipment to an AEC site for further processing. Scavenging by ferric hydroxide as a means of carrying the transplutonics was unsatisfactory. Two support studies were made at Frankford Arsenal. The first showed the feasibility of jetting uranium targets with velocities sufficient to outrun the shock wave from an underground nuclear explosion. The second study indicated that conventional explosives in a radial pipe from the nuclear device can provide sufficient counter-pressures to keep a sampling pipe open during and after the nuclear detonation. (auth)

39200 (ORNL-3452(p.239)) PREPARATION OF URANIUM-232. (Oak Ridge National Lab., Tenn.).

The preparation of U^{232} for neutron cross section measurements was completed. A total of 32.9 mg of U^{232} containing from 180 to 350 ppm U^{233} was prepared previously, and 1.04 g of U^{232} containing 0.72 wt % U^{233} was prepared during the past year. The U^{232} was produced by the neutron irradiation of approximately 45 g of Pa^{231} irradiated as an Al–Pa_2O_5 cermet. Chemical separation was accomplished by two cycles of anion exchange from mixed HCl–HF solution, followed by a uranium extraction into 20% TBP from 6M HNO_3. (auth)

39201 (ORNL-3452(p.240-51)) ASSISTANCE PROGRAMS. (Oak Ridge National Lab., Tenn.).

The Eurochemic assistance program was continued by providing the U. S. Technical Advisor, E. M. Shank, to Eurochemic for the construction phase of the Eurochemic

Plant at Mol, Belgium, and for the subsequent startup period. Construction of the high-radiation-level analytical facility was begun and scheduled for completion early in 1964. The plant waste improvements currently being designed and built are a separate Melton Valley collection and transfer system for low- and intermediate-activity-level waste, an intermediate- and high-activity-level waste evaporator, and a pair of 50,000-gal, high-activity level, water-cooled, stainless steel, acid-waste storage tanks. Design of process equipment for the evaporator facility is complete. Design of the waste storage tanks was also completed. The MSCR fuel-processing design study and cost estimate was expanded to determine the economics in recovering the protactinium in the waste salt after the first processing. This study showed that at a plant capacity of about 3 kg of U^{235} per day an annual saving of $150,000 could be achieved by discarding the protactinium. An interim alpha laboratory was designed and is being built. Fuel cycle costs were evaluated for a variety of reactor stations for the production of water and possibly electricity. The base case studied was a heavy-water-moderated, light-water-cooled, natural-uranium reactor using the nested tube element. Fuel cycle throughputs ranged from 1 to 30 short tons of uranium per day. The fuel cycle costs were also determined for the same fuel element when the irradiated fuel was discarded rather than processed at 10 and 30 tons per day, and when plutonium and depleted uranium replaced the natural uranium at 1 to 30 tons per day. An attempt was made to examine on a comparable basis a partially enriched fuel of the Dresden type at 10 tons per day. These studies indicated: unit costs are rapidly reduced by increase in production requirements; natural-uranium fuels have the lowest fuel cycle costs; and burnup and inventory are the major factors in fuel cycles for slightly enriched uranium. Radioisotope-source fabrication and Pu^{239} and U^{233} fuel fabrication in privately owned radiochemical plants are expected to increase greatly during the next decade. The potential economic loss from off-site damage due to accidents in such plants was evaluated. With the safeguards in design and operation normally included in a radiochemical plant the worst contained accidents are not expected to result in a monetary loss due to damage to the surroundings which could exceed the limits of presently available insurance (60 million dollars). As in the case with large power reactors, however, catastrophic accidents involving loss of containment in these facilities, although having such an extremely low probability of occurrence as to be considered incredible, could result in damage to the surroundings amounting to billions of dollars, particularly when normal inventories of Pu^{238}, Sr^{90}, and Pu^{239} are involved. Uncontained accidents involving U^{233} or Kr^{85}, on the other hand, would result in potential liability of a million dollars or less. The results of the study provide values of relative liability for plants that fabricate or process a variety of radioisotopes of current interest, and they provide rough estimates of the potential economic loss that could be incurred in major accidents. Radioactive material inventory, containment properties, meteorology, and surrounding population distribution all affect the potential monetary loss. (M.C.G.)

39202 THE DECANNING INSTALLATION AT MARCOULE. M. Alles. Energie Nucl., 5: 257-62(June 1963). (In French)

The design of the decanning equipment was governed by the selection of water as a shield against radiation. The fuel elements, enclosed in Al containers, are removed from the reactor and stored in a decay pool. After a suitable decay period, the fuel elements are removed to the decanning unit where the aluminum tubes are removed by extrusion. The rods are stored under water before being sent to the plutonium extraction plant. In four years of operation there has been no incident because of radioactivity. (J.S.R.)

39203 THE PLUTONIUM EXTRACTION PLANT AND ITS OPERATION. C. Jouannaud. Energie Nucl., 5: 263-70(June 1963). (In French)

The flow-sheet of the plutonium extraction plant at Marcoule is given and briefly described. The process is divided into four phases: nitric acid dissolution of the fuel, extraction of the fission products, separation of the U from the Pu, and decontamination and purification of the U and Pu. The problems posed by the industrial processing of irradiated fuels include the presence of highly radioactive fission products, the high yields of Pu necessary, and the precision necessary in the chemical analyses. The operational experience gained with the plant is reviewed briefly. (J.S.R.)

39204 THE PLUTONIUM EXTRACTION INDUSTRIAL UNIT AT MARCOULE. THE PLANT, ITS DEVELOPMENT, AND ITS ANNEXES. R. Curillon and M. Coeure. Energie Nucl., 5: 271-81(June 1963). (In French)

During a brief description of the extraction, concentration, and purification processes, which result in Pu, uranyl nitrate, and fission products from irradiated fuel elements, the selection of techniques and equipment, and the modifications made to the original methods are explained. A new continuous dissolution process is emphasized. A detailed description of the "Atelier 100," a new Pu purification unit, shows the particular elements of the plant designed to control the radioactivity, metal toxicity, and criticality problems. (J.S.R.)

39205 PILOT PLANT FOR THE TREATMENT OF IRRADIATED FUELS. H. Guillet. Energie Nucl., 5: 322-5(June 1963). (In French)

The purposes of the pilot plant are briefly indicated as an introduction to a description of the plant itself. The novel features of the plant are the gamma shielding, pulse columns, radioactive chemical transfer equipment, and the sampling-analysis system. (J.S.R.)

39206 REMOTE HANDLING AT THE PILOT PLANT FOR PROCESSING IRRADIATED FUEL ELEMENTS. F. Niezborala and A. Calame. Energie Nucl., 5: 326-8 (June 1963). (In French)

The remote control equipment used in the decontamination, fuel-element dismantling, and transport is described. The techniques used in the repair and replacing of contaminated apparatus are discussed. As an example of the remote control handling, the "bubble-to-bubble" apparatus of the dissolution cell is described. (J.S.R.)

39207 LABORATORY STUDY ON THE CHLORINATION REPROCESSING OF NEUTRON-IRRADIATED URANIUM FUELS. 5. SEPARATION OF CESIUM AND REGENERATION OF URANIUM DIOXIDE. D. Nauman (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 6: 410-11(Aug. 1963). (In German)

Uranium can be separated from the chloride melt by melt electrolysis or by precipitation methods. For the recovery of uranium after chlorination reprocessing these methods yield a purification factor for fission-product cesium of two orders of magnitude. The uranium exists after precipitation as coarse crystals of UO_2 powder. (tr-auth)

39208 FLUORIDE VOLATILITY SYSTEM (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). (CAPE-1022)

The system is used to recover uranium and plutonium from spent reactor fuel elements. Solid fuel elements are dissolved by conversion of the spent fuel into fluorides. Upon distillation, volatile uranium hexafluoride comes off as a vapor leaving plutonium and the fission products in the solid residue. Plutonium is extracted with an organic solvent. The system consists of a still, condenser, solvent recovery column, and a reflux splitter. The still is 14 in. long and is constructed of 6.4375 in. ID Monel tubing. The still has a capacity of 1.3 gal. The condenser is 36 in. long and of 3 in. dia copper tubing. Coils on the condenser are 0.5 in. OD copper tubing coiled with 10 turns in 12 in. The solvent recovery column is 85.5 in. long and is fabricated from 2 in. dia 40-schedule Monel pipe. It is packed with protruded nickel distillation packing. (F.L.S.)

39209 ELECTROLYTIC OBTAINING OF URANIUM AND THORIUM FROM MOLTEN SALTS. Wadim Rafalski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). 43p. (CONF-207-9). (In Polish)

From Second Yugoslavian Polish Symposium on Uranium Technology and Metallurgy, Zakopane, Poland, Sept. 1963.

A study was made on the separation of compact uranium on a laboratory scale from uranium oxides, using molten salt electrolysis, at 1200°C. Experimental data are included on the separation of compact thorium–zinc alloys, using the method of electrolytic co–deposition of Zn and Th from molten fluoride baths, at 1100°C. The density of the cathodic current applied was ~6 A/cm^2. (auth)

39210 NEW RESULTS OBTAINED IN THE INVESTIGATION OF COPRECIPITATION. Tadeusz Adamski, Róża Przytyoka, Loch Trojanowski, and Bogdan Zukowski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). 39p. (CONF-207-1). (In Polish)

From Second Yugoslavian Polish Symposium on Uranium Technology and Metallurgy, Zakopane, Poland, Sept. 1963.

A new technique of very slow precipitation of sparingly soluble salts to obtain sediments of crystallites of barium chromate is described. Different shapes of the crystallites are supposed to be formed due to the presence of impurities of reagents, acting as specific crystallization centers. A number of characteristic features were observed and are described, such as effects that are supposed to be radiation effects provoked by traces of radium in chromates. It was found that, using the described method, even traces of radium can be removed from uranium solutions by coprecipitation with barium chromate. The logarithmic distribution coefficient and its dependence on the pH of the parent solution was also determined. The coefficient increases with decreasing pH. (P.C.H.)

39211 IMPROVEMENTS RELATING TO THE PURIFICATION OF ORGANIC SOLVENTS CONTAINING FISSION PRODUCTS. Kenneth Hartley (to United Kingdom Atomic Energy Authority). British Patent 934,734. Aug. 21, 1963. Filed July 7, 1961.

A method for the removal of fission products from an organic solvent, which has been used in the processing of nuclear fuel, is patented. Nascent H is liberated in the solvent to condition the fission products for extraction to a washing medium. The solvent is agitated with the washing medium in contact with a nascent H source. The nascent H may be liberated electrolytically, using an aqueous solution of sulfuric acid as the electrolyte and the washing medium. An apparatus for carrying out the washing process is diagrammed. (M.P.G.)

39212 METHOD FOR CONVERTING MASSES OF ZIRCONIUM AND URANIUM TO STABLE SOLUTIONS. Theodore Arthur Gens (to United States Atomic Energy Commission). German Patent 1,150,369. June 20, 1963. Priority date Mar. 7, 1960, United States.

A method for chemically reprocessing solid uranium–zirconium fuel elements is described. This method comprises the steps of treating the fuel at about 100°C with a watery 4- to 6-molar solution of fluoride of ammonium to which (according to the uranium surplus) peroxide, e.g., hydrogen peroxide, was added, and of converting the resulting uranyl salt by adding nitric acid to a state from which the uranium can be extracted with an organic solvent. (NPO)

39213 HYDROLYTIC METHOD OF SEPARATING RARE EARTH METALS. A. I. Ryabinin and Yu. A. Koz'min. Russian Patent 152,957. Feb. 1963.

A hydrolytic method of separating rare earth metals, for example, separation of lanthanum from the rare earth elements accompanying it (except for cerium) with the use of synthetic organic anionites is discussed. The method is distinguished by the fact that, in order to increase the quantity and purity of the product being obtained, the rare earth elements are precipitated from the initial solutions under static conditions with the aid of synthetic organic anionites in hydroxyl form. (OTS)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

Refer also to abstracts 39291 and 40319.

39214 (APEX-660) DEVELOPMENT OF RADIANT FURNACES FOR HIGH-TEMPERATURE TESTING. J. B. Conway and D. G. Salyards (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). June 30, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 76p.

The development of high-temperature radiation-type furnaces is discussed. These furnaces were designed to heat ceramic fuel tubes externally at thermal flux densities which would impose thermal stresses on the tube comparable to those anticipated for internal power generation during reactor operation. The use of external heating techniques was necessary because of the high electrical resistance of the fuel tubes which precluded internal heat generation by the usual methods of conduction and induction. Several furnace types have been developed which have shown the ability to operate continuously for well over 1000 hours. The resistively heated tungsten rod furnace and the inductively heated tungsten muffle furnace appear to be the most reliable and capable of the highest performance. (auth)

39215 (IDO-14612) TESTING OF PUMPS FOR USE IN NITRIC ACID–ALUMINA SLURRY SERVICE. E. J. Bailey (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). May 1963. Contract AT(10-1)-205. 24p.

Two different types of centrifugal pumps were used successfully for pumping a nitric acid-alumina slurry produced in the off-gas scrubbing system of the Waste Calcining Facility. Adequacy of a vertical, suspended-shaft, centrigugal, double-volute pump with non-wetted bearings and packing was demonstrated in plant-scale tests. A vertical deep well turbine-type pump, with the submersed bearings made of boron carbide working against Type 440-C hardened stainless steel, also proved to be acceptable for this service in pilot plant tests. (auth)

39216 (LADC-5844) CRYO-ENGINEERING IN THE NUCLEAR ROCKET PROGRAM. E. F. Hammel (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 15p. (CONF-176-1)

From Cryogenic Engineering Conference, Boulder, Colo., Aug. 1963.

The advantages, principles, and possible configurations of nuclear rocket engines are reviewed, and the development and testing of engines in which hydrogen is heated by a reactor are outlined. The provision, handling, and control of the liquid hydrogen are stressed. (D.C.W.)

39217 (NAA-SR-Memo-8582) EDGE ROTATION AND DEFLECTION OF A CONE FOR SEVERAL LOADING CONDITIONS. C. C. Rampton (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 5, 1963. Contract [AT(11-1)-Gen-8]. 40p.

Many times a cone is required to carry an axially symmetric vertical load which will induce an axial shear load on the edge of the cone. The equations given in "Theory of Plates and Shells," Second Edition, by Timoshenko and Woinowsky-Krieger, Chapter 16, are used to derive simple expressions for the analysis of a cone. The edge rotation and deflection of a cone is given for the following types of loading: 1) edge moment, 2) radial edge thrust, 3) axial edge shear, 4) pressure loading. (auth)

39218 (NAA-SR-Memo-8670) STRUCTURAL ANALYSIS OF A HEXAGONAL BOX UNDER INTERNAL PRESSURE. L. Goodman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 26, 1963. Contract [AT(11-1)-Gen-8]. 10p.

A structural analysis of a hexagonal fuel-element box under internal pressure is made, and the necessary equations to determine the maximum stresses and the total expansion of the box are derived. The results of the analysis indicate that the maximum stresses will occur in the box corner. These stresses are due primarily to the bending moment at the juncture of the corner and the box wall. The major contribution to the expansion of the box is due to thermal expansion. For an APM box with an internal pressure of 40 psi, 5.016 in. across the flats, at 700°F, having a wall thickness of 0.175 in. and a corner radius of 0.200 in.; the total box expansion, across the flats, is .052 in. (.042 in. due to thermal expansion). The maximum stress is 6250 psi. The results for the same box with corner radii varying from 0.10 to 0.25 in. and wall thickness varying from 0.150 to 0.205 in. are available from graphs of the stresses and expansions. (auth)

39219 (NAA-SR-Memo-8728) MOMENT AREAS AND CENTROIDS OF A 90° CIRCULAR BEAM. C. C. Rampton (Atomics International. Div. of North American Aviation Inc., Canoga Park, Calif.). July 11, 1963. Contract [AT (11-1)-Gen-8]. 25p.

The approximate moment areas and centroids for a 90° circular beam, loaded in its plane of curvature, are calculated by dividing the curved member into ten straight segments and summing up the moment areas for each segment. A sample problem in the analysis of two-dimensional piping systems is worked out using these centroids and moment areas. (auth)

39220 (ORNL-TM-674) BUILDING 3019 VESSEL OFF-GAS FILTER. B. B. Klima (Oak Ridge National Lab., Tenn.). Sept. 6, 1963. Contract [W-7405-eng-26]. 27p.

A deep bed glass fiber filter was designed, fabricated, and installed in the ten-inch vessel off-gas line as it leaves Bldg. 3019. The discharge from this filter goes to the 3039 stack. The efficiency of this filter at normal gas flow rates is equivalent (99.96%) to the "absolute" type filters; however, it is capable of passing without damage to the filter many times the normal gas flow rate with a small reduction in efficiency. The fabrication, test, and installation of a filter at Bldg. 3019 are described. A program of tests to be conducted periodically to establish feasibility and applicability of this type of filter to vessel off-gas service at ORNL is also outlined. (auth)

39221 (TID-19476) THE APPLICATION OF GAS-LUBRICATED BEARINGS TO HIGH-SPEED, TURBOMACHINERY. Quarterly Technical Report, March 1–May 31, 1963. E. J. Gunter, Jr., J. G. Hinkle, and D. D. Fuller (Franklin Inst. Labs. for Research and Development, Philadelphia). Contract AT(30-1)-2512. 7p. (Q-A2392-3-9)

Effort was applied to the design and analysis of both self-acting and externally-pressurized gas-lubricated bearings. The major emphasis is now being placed on the investigation of the performance characteristics of self-

acting, pivoted pad, journal bearing arrangements. The operating experiences encountered while using external pressurization on the two lower shoes of each tilting-pad journal bearing of the SA-2 rig are reviewed. The external pressurization is achieved by supplying compressed air through a drilled pivot pin which meters with a corresponding hole passing through the pad itself to the journal interface. (auth)

39222 (UCRL-7393) SOME NEW TECHNIQUES IN ULTRA-HIGH VACUUM. Thomas H. Batzer and James F. Ryan (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 12, 1963. Contract W-7405-eng-48. 14p. (CONF-209-2)

From American Vacuum Society Meeting, Boston, Oct. 1963.

Simple, reliable metal gaskets of aluminum foil have led to several new techniques. These seals permit prolonged temperature excursions from liquid-nitrogen temperature to 450°C. Using foil seals, the outgassing characteristics of a 50-liter aluminum alloy vessel were investigated. The vessel was baked to 240°C. The gas composition and evolution rate was determined with and without a molybdenum getter-trap in series with the liquid-nitrogen trap. The trap, getter, and valve were separately baked to 400°C. The complete absence of pressure fluctuations typical of diffusion pumped systems in the range of 10^{-10} Torr is credited to a special zeolite backing pump which eliminated mechanical-pump contamination by doubling as a trap during roughing. (auth)

39223 (UCRL-7399-T) DETECTION OF LEAKS AND MERCURY VAPOR IN VACUUM SYSTEMS BY ANALYZING LIGHT FROM DISCHARGES. Norman Milleron (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 20, 1963. Contract [W-7405-eng-48]. 14p. (CONF-209-1)

From American Vacuum Society Meeting, Boston, Oct. 1963.

At $\sim 5 \times 10^{-6}$ torr total pressure, $< 5 \times 10^{-9}$ torr partial pressure of Hg is detected in terms of the intensity of 2537Å light issuing from a Penning discharge cell discharge. For leak detection, two methods using the same discharge cell geometry are used. Between ~0.1 and $< 1 \times 10^{-6}$ torr, characteristic spectra from gases (helium, etc.) is analyzed by gratings or prisms or interference filters and monitored by photomultiplier tube detectors. Between 0.5 and 10 torr, established against air leaks, no magnetic field is used; and the change in total visible light from the discharge cell, picked up by a photo cell, rises sharply when the leaks are probed with He, Ne, or Ar. The on-set response of the detector is limited by system volume; and helium clean up is set by the pumping time constant of the system. (auth)

39224 (UCRL-10953) DRY SCRUBBER UNIT FOR LOW-LEAK VENTILATION SYSTEMS. Jensen Young, Wayne T. Pearce, and Thomas C. Parsons (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 7, 1963. Contract W-7405-eng-48. 11p.

To "air-condition" primary enclosures of 4-ft and 6-ft water neutron facilities used when separating and purifying transcurium elements, an improved dry scrubber unit was developed and tested at the Lawrence Radiation Laboratory in Berkeley. Construction of the unit, laboratory tests, and operating data are described. (auth)

39225 APPROXIMATE BURST STRENGTH OF THIN-WALLED CYLINDERS WITH HEMISPHERICAL CAPS. N. A. Weil, M. A. Salmon, and C. J. Costantino (IIT Research Inst., Chicago). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 2088-92(Sept. 1963).

An approximate solution is presented for the bursting strength of thin-walled cylinders with hemispherically capped ends. Deformation theory of plasticity is used, together with the Mises yield criterion and its associated flow rule. Solutions are presented for materials that strain-harden according to a Ludwik power law relationship. Results obtained are compared with those for cylinders with rigid ends to determine the influence of end restraint on burst pressure. Numerical results are presented for cylinder lengths varying from zero to infinity and for a range of hardening coefficients from 0 to 1.0. For cylinders with a length/diameter ratio l larger than 2, the effect of end restraint, as represented by spherical heads or rigid caps, upon the burst strength is small, amounting to less than 13%. However, for values of $l < 2.0$, this effect becomes significant, the rigidly capped cylinder being considerably stronger than the hemispherically headed one. Furthermore, both shells are considerably stronger than the infinitely long cylinder. (auth)

39226 DETERMINING THE PENETRATION OF HELIUM THROUGH THE WALL OF A TUBE. I. S. Lupakov, Yu. S. Kuz'michev, and Yu. V. Zakharov. At. Energ. (USSR), 15: 79-80(July 1963). (In Russian)

The penetration of helium through the walls of a metal tube 35 mm in diameter and 600 mm long was determined by pressurizing the tube to 150 atm with helium gas, and measuring the helium pressure in the evacuated space around the metal tube by means of a helium leak detector. The pressurized tube could also be heated by means of a resistance tube furnace. The helium penetration can be expressed by the following formula: $Q = \Delta pv/760tS$. Here Δp is the change in pressure in mm Hg std due to the penetration of helium, v is the volume of the evacuated space (7.5 liters), S is the surface (300 cm^2) of the heated metal tube, and t is the time for the pressure to change by an amount Δp. The tubes were tested in place for leaks before the experiment. The penetration of helium through two types of stainless steel tubes and one nickel alloy tube at 600°C was found to be about 1×10^{-9} $1/cm^2$-sec. (TTT)

39227 PLASTIC INSTABILITY OF CYLINDRICAL SHELLS WITH RIGID END CLOSURES. Martin A. Salmon (Illinois Inst. of Tech., Chicago). J. Appl. Mech., 30: 401-9(Sept. 1963).

Solutions are obtained for the large plastic deformations of a cylindrical membrane with rigid end closures subjected to an internal pressure loading. A plastic linearly hardening material obeying Tresca's yield criterion and the associated flow rule is considered. It is found that, in general, a shell passes through three stages of deformation, finally assuming a spherical shape. The instability pressure (maximum pressure) may be reached in any of the stages depending on the length/diameter ratio of the shell and the hardening modulus of the material. Although numerical integration is required to obtain solutions for shells in the first stages of deformation, the solution in the final state is given in closed form. (auth)

39228 CAVITATION DAMAGE TO CENTRIFUGAL PUMP IMPELLERS DURING OPERATION WITH LIQUID METALS AND MOLTEN SALT AT 1050-1400 F. P. G. Smith, J. H. DeVan, and A. G. Grindell (Oak Ridge National Lab., Tenn.). J. Basic Eng., 85: 329-37(Sept. 1963).

Three centrifugal pump impellers fabricated of Inconel were subjected to endurance testing under cavitating conditions with sodium and with molten salt (fused fluorides)

at temperatures of 1050 to 1400°F. The tests were run (one with sodium and two with molten salt) at or near pump design head and flow conditions to establish the extent of impeller damage sustained during long periods of operation and to observe the effects upon performance. Descriptions are provided for the test impellers and volutes, of the experimental apparatus, and of the test operations. The cavitation damage is described by the effects on hydraulic performance and with photomicrographs and metallurgical analyses. Damage was manifested by the formation of pits in excess of $\frac{1}{4}$ in. in depth. No change in performance was detected. (auth)

39229 LABORATORY PLANNING AND EQUIPMENT—TECHNICAL RADIATION PROTECTION IN OPERATOR'S ROOMS. G. Siewert. Kernenergie, 6: 428-36(Aug. 1963). (In German)

A review of the development and state of laboratory construction in the German Democratic Republic for the equipment of laboratories for work with radioactive materials is given. (tr-auth)

39230 REMOTE ANALYTICAL FACILITY (Engineering Materials). (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). (CAPE-631)

The facility provides space for technical development of new processes dealing with expended fuel elements and for analytical process control. The building is constructed of reinforced concrete, is 88 × 83 ft, and is divided into three parallel areas: analytical, decontamination, and multicurie cells. The analytical area contains both remote and conventional laboratories. The remote laboratory contains 32 Berkeley-type boxes which are arranged in two lines. Also included are manipulators, dollies, carriers, conveyors, tongs, and cabinets. (F.L.S.)

39231 SERVICE SLEEVES FOR THE FAST REACTOR CORE TEST FACILITIES (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-1023)

The 3 and 6 in. service sleeves are used in hot cells in the Fast Reactor Core Test Facility. This facility was designed for testing and evaluating a sequence of plutonium-fueled, sodium-cooled reactor core concepts. The 3 in. sleeve is 42 in. long, 3.125 in. OD and 2.625 in. ID of seamless mechanical tubing. The 6 in. sleeve is either 42 or 48 in. long with 6 in. OD and 5.25 in. ID of seamless tubing. The 6 in. shielding sleeve is used in the Na–Pu Disassembly Cells. The 3 in. sleeve is used in the Gas Clean-Up Cell. (F.L.S.)

39232 DRY SCRUBBER UNIT FOR LOW-LEVEL VENTILATION SYSTEM (Engineering Materials). (California. Univ., Berkeley. Lawrence Radiation Lab.). (CAPE-1034)

The improved dry scrubber is used by the Health Chemistry group to air condition the primary enclosures of 4 and 6 ft water-neutron facilities during the separation and purification of transcurium elements. The unit consists of an air filter and a container in which the scrubbing materials are arranged. The air filter is contained in a plywood unit 10.5 × 8 × 8 in. The filters are glass-asbestos fiber membranes. The container is a 30 gal. drum, 19 in. in dia, with a removable head. Inside the drum, starting at the base, there is a 20 lb molecular sieve, a filter, a second 20 lb molecular sieve, a second filter, 9 lb of soda lime and a 10 lb layer of activated charcoal. A blower, separator and additional filters are above these inside the drums. (F.L.S.)

39233 TOP-POUR VACUUM INDUCTION FURNACE. (Engineering Materials). Argonne National Lab., Ill.). (CAPE-1032)

The top-pour vacuum induction furnace is used in a glove box for metallurgical application. The furnace consists of a base plate, induction coil, metal bell jar, and a ceramic crucible. The bell jar is 14 in. OD and is fabricated of 10-gauge, seamless, 304 stainless steel 8.375 in. long. The cap is a "Zephyrweld" tube cap of 10-gauge, 302 stainless steel. The induction coil is 0.375 in. OD and is fabricated of copper tubing with a 0.031 in. wall thickness. The ceramic crucible is a 1.625 in. ID cylinder 4 in. long. The melt is heated by the induction method with a 3 to 5 kev 10,000 cycle generator. The tilting mechanism and power leads are one integral vacuum-tight unit that penetrates the base plate in a co-axial arrangement. Auxiliary equipment including a 4 in. vacuum system and a high-frequency generator are located outside the glovebox. (F.L.S.)

39234 IMPROVEMENTS IN OR RELATING TO DISMOUNTABLE FILTER SUPPORTS. Andre Rouguin and Rene Donguy (to Commissariat à l'Energie Atomique). British Patent 933,794. Aug. 14, 1963. Priority date May 17, 1960, France.

A filter support, which holds a rapidly replaceable, remotely controlled filter with a large filtration area, is patented. The filter may be used for treating fluids under pressure in general, and gases containing radioactive dusts in particular. The support consists of a cylindrical housing for the filter and 2 casings at the ends of the housing, which slide in a sleeve surrounding the housing and can be removed from the sleeve. Hollow rods at one end of each casing slide in a fluid-tight manner inside the inlet and outlet conduits for the fluid to be filtered, or the casings can slide around a hollow rod connected to the conduits. In an alternative design, only one casing is slidable, the other being connected to the sleeve. (M.P.G.)

39235 IMPROVEMENTS IN OR RELATING TO VACUUM CLEANERS. David Gordon Stevenson (to United Kingdom Atomic Energy Authority). British Patent 934,293. Aug. 14, 1963. Filed June 23, 1961.

The design of a vacuum cleaner, which is suitable for handling radioactively contaminated liquids and solids, is patented. The cleaner contains a separator, such as a cyclone separator, with two outlets, one leading to a liquid-tight bag and the other leading to a bag filter for gas and dust. The liquid-tight bag and the bag filter are supported within the same atmosphere in a container. The pressure of the atmosphere in the container can be reduced to operate the cleaner. (M.P.G.)

Heat Transfer and Fluid Flow

Refer also to abstracts 40265, 40268, 40269, 40311, and 40345.

39236 (BNL-6692) ON THE TRANSFER OF HEAT TO FLUIDS FLOWING THROUGH PIPES, ANNULI, AND PARALLEL PLATES. O. E. Dwyer (Brookhaven National Lab., Upton, N. Y.). Jan. 8, 1963. Contract AT-30-2-GEN-16. 41p.

Nusselt numbers were calculated for heat transfer to fluids flowing through annuli under conditions of uniform heat flux and fully established velocity and temperature profiles. The following cases were considered: (a) laminar flow, (b) slug flow, (c) turbulent flow with molecular conduction only, and (d) turbulent flow with both molecular and eddy conduction. These Nusselt numbers were determined for two conditions: heat transfer from the inner wall only and heat transfer from the outer wall only. The results were correlated by semi-empirical equations. The

final results obtained on cases (a), (b), and (c) are applicable to any fluid, whereas those obtained on (d) are for liquid metals only. Wall- and bulk-temperature relationships for the above four cases were also determined. These relationships were treated as dimensionless temperature ratios. Both the Nusselt numbers and temperature ratios were evaluated over the r_1/r_2 range, zero to unity; the former being the case of the circular pipe, and the later, the case of infinite parallel plates. (auth)

39237 (EUR-303.i) STUDIO DI UNA NAVE CISTERNA A PROPULSIONE NUCLEARE. DESCRIZIONE DEL CIRCUITO DA 100 kW A CIRCOLAZIONE NATURALE PER ACQUA AD ALTA PRESSIONE DEL POLITECNICO DI TORINO. (Study of a Nuclear Powered Tanker. Description of the 100 kW Natural Circulation High Pressure Water Loop: Installed at the "Politecnico" of Torino). C. Arneodo, C. Merlini (Turin. Politecnico); G. Gaudiosi, A. Merelli (Italy. Comitato Nazionale per l'Energia Nucleare, Rome); and B. Migliorati (FIAT. Sezione Energia Nucleare, Turin). 1963. 60p.

Presented is a detailed description of the natural circulation pressurized water loop operating at the "Politecnico" (Technical University) of Torino. By using this loop, it is possible to investigate burnout and instability phenomena; moreover mathematical models can be checked. The maximum installed power of 100 kw d-c heats the vertical test section, in which water is flowing at a maximum pressure of 300 kg/cm^2. The main components of the loop (pressurizer with electrical heaters, heat exchanger, motor operated valve, etc.) and the auxiliary systems (cooling, purifying, charging, vent and drain) are described. Flow, pressure and temperature rates can be recorded by using high sensitivity and precision instrumentation. A typical testing procedure is described and the installation cost breakdown is also given. (auth)

39238 (EURAEC-630) RESULTS OF BURNOUT AND INSTABILITY EXPERIMENTS OF A 7-ROD BUNDLE UP TO 30 ATMOSPHERES PRESSURE. SECOND SERIES WITH INLET SUBCOOLING AND NATURAL CONVECTION. Special Technical Report No. 7. R. W. Bowring and C. L. Spigt (Eindhoven, Netherlands. Technische Hogeschool). Mar. 1963. Work Performed under United States–Euratom Joint Research Establishment Program. Contract 032-60-RDH. 62p.

Burnout and hydraulic stability experiments were carried out at saturation temperatures and pressures of 230°C (28 atmos), 200°C (15 atmos), 180°C (10 atmos) and 140°C (3.6 atmos) with a 7-rod bundle test section whose geometry was very close to a Halden Boiling Water Reactor second charge fuel element. In this second series, the inlet subcooling could be varied and the water velocity was determined by natural circulation. The dimensions of the rods in each test section were the same within the manufacturing tolerance. They were heated electrically and connected in parallel to give equal heat rating of the rods. Locally high heat fluxes to probe burnout were obtained by machining the inside of the tube wall so that the increased electrical resistance would produce a "hot patch," without change in the OD of the rod. The method of operating was to stabilize the system at the required pressure and subcooling (corresponding usually to the heat losses +0 or 30 kw heat removed in the external Subcooler). The channel power was increased until the burnout detectors indicated imminent burnout or the limits of the condenser cooling capacity or rectifier current were reached. Three types of test section were used. In the first, thin-walled tube was used for the rods with hot patches of 1.5 heat flux ratio (patch to uniform). Three of the outer rods each had one hot patch at approximately $^5/_{16}$, $^{10}/_{16}$, and $^{13}/_{16}$ respectively of the way up the test section and the middle rod a hot patch $^{13}/_{16}$ of the way up. Burnout detectors were connected to the two rods with the top hot patches. In the second type of test section, thick-walled tube was used for the rods with hot patches of 2.3 heat flux ratio. The middle and one of the outer rods each had two hot patches at approximately $^1/_8$ and $^3/_8$ up the test section. The burnout detectors were connected to these two rods. The third type of test section was similar to the second except that a constriction was placed above the top spacer and some of the shroud exit holes blocked to simulate a locked upper turbine in the chimney of an Instrumented Fuel Assembly. The first type of test section failed at high power due to the melting of the copper inserts (these confined the electrical heating to the two 800 mm lengths simulating the two stringers of the reactor fuel element). Except for some limited power runs and the first approach to burnout at 230°C with 40 kw subcooling, data obtained with this test section are considered to be unreliable. With the second type of test section, burnout did not occur at 230°C at a channel power of 600 kw (the rectifier current limit) with 14 and 40 kw subcooling when the uniform heat flux was 133 w/cm^2, the highest heat flux in the patch 292 w/cm^2 and exit quality about 20%, but did at 550 kw when the subcooling was increased to 94 kw. At lower temperatures, the maximum channel powers reached at low and high subcooling respectively were 200°C, 528 and 572 kw (condenser limit and burnout trip respectively); 180°C, 500 and 500 kw (both burnout detector trip); 140°C, 342 and 380 kw (condenser limit and trip respectively). With the third type of test section (Instrumented Fuel Assembly simulation), burnout trip occurred at 230°C, 14 kw subcooling at a channel power of 527 kw. The natural circulation inlet velocity was measured as a function of channel power. At 230°C the maximum velocity was 88 cm/sec at a channel power of about 150 kw. The channel power at the maximum in the velocity curve increased with increasing subcooling and decreased with decreasing temperature. The oscillations in inlet velocity were recorded on a Visicorder. The types of oscillation were arbitrarily divided into three types: noise, noisy periodic, and periodic. A noisy periodic flow trace showed mainly noise with bursts of periodic oscillation lasting a few periods and then dying away again. The transition from noise to noisy periodic flow oscillations occurred approximately as follows: 230°C, 600 kw; 200°C, 500 kw; 180°C, 450 kw and 140°C, 325 kw. Examples of burnout trip occurring at each type of flow oscillation were obtained and recorded. The majority of the burnout trips occurred with the top half of the middle rod of the bundle overheating under conditions of noisy periodic or periodic flow oscillations. The effect of the exit constriction in the test section simulating an Instrumented Fuel Assembly was to reduce the safe power at 230°C from ≥600 kw to 527 kw, the maximum velocity from 88 cm/sec to 60 cm/sec and to make the system less stable hydraulically. Trip occurred during a period of divergent periodic velocity oscillations. The data obtained in these tests will be used for the assessment of the burnout hazard in HBWR II. (auth)

39239 (EURAEC-712) ADIABATIC DISPERSED TWO-PHASE FLOW: FURTHER RESULTS ON THE INFLUENCE OF PHYSICAL PROPERTIES ON PRESSURE DROP AND FILM THICKNESS. Topical Report No. 6. I. Casagrande, L. Cravarolo, A. Hassid, and E. Pedrocchi (Centro Informazioni Studi Esperienze, Milan). May 1963. Work Per-

formed under United States–Euratom Joint Research and Development Program. Contract 060-61-7-RDI. 75p. (CISE-R-73)

A discussion is given of the experimental data obtained at CISE on two-phase adiabatic flow under the following conditions: vertical upward (dispersed regime) flow; circular conduit (15 to 25 mm diameter); gaseous phase argon or nitrogen; liquid phase water or ethyl alcohol-water solution (~90% by wt. of alcohol); gas flow rate of 15 to 82 g/cm^2; liquid flow rate of 20 to 206 g/cm^2 sec; temperature of 18 to 20°C; pressure of up to ~22 kg/cm^2. The measured quantities are pressure drop and liquid film thickness on the wall of the conduit. The pressure loss and film flow rate are evaluated. The experimental data are discussed and the influence of surface tension and gas and liquid viscosity investigated. A simple relationship for the pressure loss over a wide range of experimental conditions in adiabatic dispersed regime is given. (auth)

39240 (JPL-TR-32-508) LITHIUM–BOILING POTASSIUM REFRACTORY METAL LOOP FACILITY. J. P. Davis, G. M. Kikin, W. M. Phillips, and L. S. Wolfson (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Aug. 31, 1963. Contract NAS 7-100. 19p.

A 30-kw lithium–boiling potassium two-loop facility is presently under construction at the Jet Propulsion Laboratory and is expected to be in operation during 1964. The loop is totally constructed of columbium–1% zirconium alloy and will operate at temperatures up to 2100°F. The primary purposes of this loop facility are as follows: (1) To investigate over-all transient and steady-state characteristics of a two-loop system which approximately simulates velocities, temperature, pressure, transit times, and heat fluxes in the range of actual system interest. The primary loop heat source is by direct-resistance heat generation in a section of tube wall and liquid metal, which lends itself to programming of reactor kinetic equations for simulation of power response to various system perturbations. A detailed study of regimes of boiling stability under various operating conditions, heat fluxes, exit vapor quality, inlet subcooling, etc. will be made. (2) To obtain steady-state local-boiling heat-transfer coefficients and two-phase pressure drop data for a variety of operating parameters. (3) To evaluate components such as throttling valves, centrifugal pumps, hot traps, and experimental turbine-alternators for potential application to actual systems. (auth)

39241 (TID-19446) EFFECT OF LARGE TEMPERATURE GRADIENTS ON TURBULENT FLOW OF GASES IN THE DOWNSTREAM REGION OF TUBES. Technical Report No. 247-5. Donald M. McEligot (Stanford Univ., Calif. Nuclear Technology Lab.). March 1963. Contract AT (04-3)-247. 239p.

The results of an experimental investigation of local heat transfer and frictional effects for the turbulent flow of various gases through electrically heated circular tubes are presented and compared with semi-theoretical predictions. This report is concerned primarily with the downstream region of the tube rather than with the thermal entry region, and the emphasis throughout is on the effect of large heat fluxes on the heat transfer and flow processes. In these experiments, entering Reynolds numbers range from 1500 to more than 200,000, the highest flow rates being accompanied by choking at the tube exit. Maximum tube wall temperatures range from 160 to 1850°F, wall-to-bulk temperature ratios to 2.45, heat flux to 259,000 Btu/(hr)(sq ft) and gas pressure from a few atmospheres to about twenty. Typical experimental runs show an increase in the local Nusselt numbers and friction factors in the thermal entry region followed by small reductions downstream in comparison to the constant property behavior at the same local Reynolds number and bulk static temperature. These results are in agreement with trends reported from other recent experiments, but only partially confirm semi-theoretical predictions for variable properties behavior. Recommended design correlations are expressed both in terms of a heat flux parameter, defined as the ratio of wall heat flux to entering enthalpy rate ($q^+ = q''_w/GH_i$), and in terms of the wall-to-bulk temperature ratio (T_w/T_b). This report also explores briefly the transitional regime between fully laminar and fully turbulent flow where existing analyses are completely inadequate. Analytical refinement of these constant properties analyses, experimental data for both low and high heat flux, and a heat transfer design correlation are presented. (auth)

39242 (TRG-Report-616) AN AUTOCODE PROGRAMME FOR THE STUDY OF NATURAL CONVECTION AND RADIATION IN THREE GASES, HELIUM, CO_2 AND AIR. P. A. Griffiths and J. Griffiths (United Kingdom Atomic Energy Authority. Reactor Group, Dounreay, Caithness, Scotland). Aug. 22, 1963. 6p.

The cooling mechanisms concerned in the calculation of the surface temperature of specimens situated in gas-filled thimbles are natural convection and radiation. An equation was derived for this calculation, and its solution requires trial and error methods particularly suited to the Mercury Autocode "Find Zero" routine. The method of calculation and the machine program are described, and the data to be fed in are specified. The form of the printout is shown. (auth)

39243 (EURAEC-623) INVESTIGATION OF CRITICAL BURNOUT WITH BOILING WATER. Quarterly Report No. 6; January 1 to March 31, 1963. (Maschinenfabrik Augsburg-Nurnberg A. G., Nuremberg). Apr. 15, 1963. Contract 057-61-RDD. Work Performed under United States–Euratom Joint Research and Development Program. Contract 057-61-RDD. 10p. (A translation)

Coolers, condensers, mixed bed filter, electric preheater, and the semiprefinished conduits were completed for the high-pressure test stand. A constructive investigation was made to ascertain the extent to which with high-pressure measuring lengths, the built-in test channels can be shortened when not subjected to pressure in order to carry out tests with smaller heated length and hydraulic diameter ratios. Within the given framework it is possible to obtain L/D = 20 without any great difficulties. The critical analysis of the available results of the critical burnouts is being continued. Preliminary tests were begun to determine the viscosity influence with flow capacity measurements on the measurement value indications of turbine flowmeters. The digital computer program aimed at ascertaining the fall in temperature in the heated wall was extended so as to include a check on the presumed physical material properties of the heated test channel wall or on their measurements which cannot be gauged with sufficient accuracy, so that the data given will now be checked in regard to their internal consistency as well. Theoretical investigation was also made of the connections between relative velocity of the phases (slip), void fraction, and quality. (auth)

39244 A STUDY OF THE BURN-OUT HEAT FLUX WITH FORCED CIRCULATION OF MONOISOPROPYLDIPHENYL (MIPD) SUBCOOLED BELOW THE SATURATION TEMPERATURE. G. N. Karavaev, A. D. Leongardt, and

Yu. P. Shlykov. At. Energ. (USSR), 15: 77-9(July 1963). (In Russian)

The burn-out heat flux of monoisopropyldiphenyl (MIPD) was measured in a closed stainless steel system at constant pressure, temperature, and flow rate of MIPD. The organic fluid was heated electrically. The instrument readings were taken at the moment of overheating of the fuel element. The burn-out heat flux varied from 3.7 to 4.8 × 10^6 kcal/m^2-hr at a liquid velocity of 6.3 m/sec with a variation in the amount of subcooling from 124 to 190°C. The critical heat flux varied from 2.7 to 3.6 × 10^6 kcal/m^2-hr at a liquid velocity of 4.24 m/sec with subcooling from 120 to 195°C. A plot of the burn-out heat flux as a function of the amount of subcooling shows that the burn-out heat flux increases with subcooling, as is true of other liquids. (TTT)

39245 SOME REMARKS ON THE MARTINELLI-NELSON PRESSURE LOSS CORRELATION IN TWO-PHASE FLOW. L. Cravarolo, A. Hassid, and E. Pedrocchi (Laboratori CISE, Milan). Energia Nucl. (Milan), 10: 395-6(July 1963). (In English)

The method proposed by Martinelli and Nelson to predict pressure losses in two-phase flow is discussed and improvements are suggested. (M.C.G.)

39246 LIQUID METALS FOR AEROSPACE ELECTRIC-POWER SYSTEMS. L. Rosenblum (Lewis Research Center, Cleveland). J. Metals, 15: 637-41(Sept. 1963).

Liquid metals and their properties, as applied to space electric-power systems, are discussed as possible heat-transfer and thermodynamic working fluids. Representative liquid metals, Li, Na, K, NaK-78, Pb, and Bi, are discussed and compared. Space power requirements are listed and used as a basis for evaluating the potentialities of the liquid metals. (auth)

39247 A THEORY FOR PREDICTING PRESSURE GRADIENTS FOR TWO-PHASE CRITICAL FLOW. Hans K. Fauske (Argonne National Lab., Ill.). Nucl. Sci. Eng., 17: 1-7(Sept. 1963).

Critical two-phase, steam-water flows were measured in horizontal test sections with pipe diameters of 0.125 and 0.269 in. internal diameter over a range of qualities from 0.01 to 0.7, mass velocities from 500 to 4200 lb/sec-ft^2, and critical pressures from 40 to 360 lb/$in.^2$ absolute. The critical flow data and a theory for the critical flow phenomena were discussed previously. An analysis for the pressure drop data in the approach region to critical flow is presented. The flow mixture accelerates to critical flow at the end of the test sections, and thus the pressure drop data are for flow regimes in which both momentum and frictional losses are important. By utilizing a model developed for estimating critical discharge rates two-phase friction factors were calculated from the experimental data. The friction factors obtained correlated well in terms of the two-phase quality and appear to be independent of flow rate, static pressure, and test geometry for the conditions examined. (auth)

39248 HYDROMAGNETIC COUETTE'S FLOW WITH SUCTION AND INJECTION. R. K. Rathy (Indian Inst. of Tech., Kanpur, India). Z. Angew. Math. Mech., 43: 370-4 (July-Aug. 1963). (In English)

The problem of flow between two parallel plates was investigated for the case when one plate is moving parallel to itself with a constant velocity while the other is at rest. It was assumed that an external magnetic field is acting normal to the plates. Points of inflection and maxima and minima of the velocity profile are discussed. Symmetry of the flow was investigated. Equations were also solved for the case in which the plates are stationary and there is a constant pressure gradient. (M.C.G.)

39249 AN EXPERIMENTAL STUDY OF SURFACE COOLING BY BUBBLES DURING NUCLEATE BOILING OF WATER. T. F. Rogers (Spencer Chemical Co., Merriam, Kan.) and R. B. Mesler. New York, American Institute of Chemical Engineers, 1963, Preprint 4, 15p, $0.50. (CONF-225-7)

From American Institute of Chemical Engineers 51st National Meeting, San Juan, P. R., Sept.-Oct. 1963.

An experimental attempt was made to relate the temperature drops of the surface during nucleate boiling of water to the behavior of the bubbles. It was earlier postulated by Moore and Mesler that the temperature drops were caused by the evaporation of a microlayer underneath the bubble. The results presented are consistent with this hypothesis since it is shown that the surface is cooled as the bubble grows and that there is no cooling where there is no bubble. (R.E.U.)

39250 EFFECTS OF REDUCED GRAVITY ON NUCLEATE BOILING BUBBLE DYNAMICS IN SATURATED WATER. R. Siegel and E. G. Keshock (Lewis Research Center, Cleveland). New York, American Institute of Chemical Engineers, 1963, Preprint Paper 3, 54p, $0.50. (CONF-225-8)

From American Institute of Chemical Engineers 51st National Meeting, San Juan, P. R., Sept.-Oct. 1963.

A study was made of nucleate boiling bubble dynamics in distilled water under various reduced gravity fields. The nucleation occurred on a very smooth horizontal nickel surface at low heat fluxes. Since, because of the smooth surface finish, only a few nucleation sites were active, it was possible to photograph individual bubbles that were not interfered with by adjacent bubble columns. Data were taken at seven different gravity fields in the range from 1.4% to 100% of earth gravity by placing the apparatus on a counterweighted falling platform. Measurements were made of bubble departure diameters and frequencies, growth rates, contact angles, base circle diameters, and rise velocities. Comparisons were made to determine whether the measured gravity dependence of these quantities was in agreement with that predicted. (auth)

39251 HEAT TRANSFER ACROSS SURFACES IN CONTACT: EFFECT OF AMBIENT PRESSURE CHANGES. R. L. Aaron (Hughes Aircraft Co., Culver City, Calif.) and H. A. Blum. New York, American Institute of Chemical Engineers, 1963, Preprint Paper 1, 19p, $0.50. (CONF-225-9)

From American Institute of Chemical Engineers 51st National Meeting, San Juan, P. R., Sept.-Oct. 1963.

A theoretical study of the effect of varying ambient fluid pressures at a joint shows how fast the voids in a contact might be expected to be filled or evacuated and how the temperature distribution is affected during the time to reach a new steady state condition. The thermal effects of varying ambient pressure around a joint are of considerable magnitude in many cases. These effects are of practical interest in current problems of temperature control and thermal stress. (auth)

39252 THE ROLES OF CAPILLARY WICKING AND SURFACE DEPOSITS IN THE ATTAINMENT OF HIGH POOL BOILING BURNOUT HEAT FLUXES. C. P. Costello (Univ. of Washington, Seattle) and W. J. Frea. New York, American Institute of Chemical Engineers, 1963, Preprint 19, 27p, $0.50. (CONF-225-4)

From American Institute of Chemical Engineers 51st National Meeting, San Juan, P. R., Sept.-Oct. 1963.

The use of capillary wicking material to supply coolant to a boiling surface has received much attention because capillary-fed systems may be able to perform as well or better in zero gravity environments than they do at ground level. The experiments presented were initially designed to reveal the configuration of capillary wicking which permits the highest possible heat flux from a boiling surface. The pool boiling burnout problem is discussed with this in mind. (auth)

39253 AN EXPERIMENTAL INVESTIGATION OF THE INHERENT UNCERTAINTY IN POOL-BOILING CRITICAL HEAT FLUXES TO SATURATED WATER. Wallace Gambill (Oak Ridge National Lab., Tenn.). New York, American Institute of Chemical Engineers, 1963, Preprint 18. 38p. $0.50. (CONF-225-5)

From American Institute of Chemical Engineers 51st National Meeting, San Juan, P. R., Sept.-Oct. 1963.

An attempt is made to determine if the nucleate-to-film-boiling transition, or critical heat flux, is or is not characterized by exact values. It is concluded that there is an inherent uncertainty or intrinsic randomness in the critical heat flux determined under saturated pool boiling conditions with minimum surface variability, which approximates that predicted by the hydrodynamic instability theory. (R.E.U.)

39254 THE DOMINANT UNSTABLE WAVELENGTH AND MINIMUM HEAT FLUX DURING FILM BOILING ON A HORIZONTAL CYLINDER. J. H. Lienhard and P. T. Y. Wong (Washington State Univ., Pullman). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-HT-3. 6p. (CONF-129-11)

From American Society of Mechanical Engineers, American Institute of Chemical Engineers 6th National Heat Transfer Conference and Exhibit, Boston, Aug. 1963.

Predictions of the dominant unstable wavelength and the minimum heat flux during film boiling above a flat plate are found to be inapplicable in the case of boiling on small wires. New expressions are developed for the case of a horizontal cylinder by accounting for the effect of surface tension in the transverse direction upon the Taylor instability of the interface. Original measurements of wavelengths and minimum heat fluxes on small wires are also provided. These data support the predictions. (auth)

39255 FILM BOILING OF NITROGEN WITH SUCTION ON AN ELECTRICALLY-HEATED POROUS PLATE. P. C. Wayner, Jr. and S. G. Bankoff (Northwestern Univ., Evanston, Ill.). New York, American Institute of Chemical Engineers, 1963, Preprint 22, 30p, $0.50. (CONF-225-1)

From American Institute of Chemical Engineers 51st National Meeting, San Juan, P. R., Sept.-Oct. 1963.

A new mode of heat transfer is proposed in order to avoid some of the undesirable aspects of the usual modes of boiling heat transfer. It consists of film boiling from a porous heat source with the vapor being exhausted through the heat source itself. Heat transfer coefficients several times greater than the usual film-boiling heat transfer coefficients are possible from this mode. The stabilizing effects of surface tension and evaporation on small perturbations of the liquid-vapor interface were studied, assuming that a continuous vapor film separates the liquid from the solid, excess vapor being removed as fast as it is formed by passing through the hot surface. (R.E.U.)

39256 A PHOTOGRAPHIC STUDY OF THE MECHANISM OF FORCED CONVECTION VAPORIZATION. P. J. Berenson and R. A. Stone (AiResearch Manufacturing Co., Los Angeles). New York, American Institute of Chemical Engineers, 1963, Preprint 21, 20p, $0.50. (CONF-225-2)

From American Institute of Chemical Engineers 51st National Meeting, San Juan, P. R., Sept.-Oct. 1963.

The vaporization of Freon 113 flowing inside a horizontal pyrex tube was studied with the aid of 7000 frame per second motion pictures. Heat fluxes up to 40,000 Btu/hr-ft^2 were obtained using 800°F air flowing in the space between the glass tube and a rectangular quartz duct as the heat source. The Freon entered the tube subcooled and the exit condition varied from moderate quality to superheated vapor. The two phase flow patterns and heat transfer mechanisms revealed in the photographs are discussed. The photographs lead to the conclusion that the annular-mist flow transition (forced convection vaporization burnout condition) results simply from the vaporization of the liquid annulus while liquid droplets remain dispersed throughout the vapor core. (auth)

39257 DESTRUCTION OF A THIN LIQUID FILM FLOWING OVER A HEATING SURFACE. Y. Y. Hsu, F. F. Simon, and J. F. Lad (Lewis Research Center, Cleveland). New York, American Institute of Chemical Engineers, 1963, Preprint 5, 61p, $0.50. (CONF-225-6)

From American Institute of Chemical Engineers 51st National Meeting, San Juan, P. R., Sept.-Oct. 1963.

Heating of a thin liquid film, such as occurs in annular flow or on wetted-wall columns, may cause formation of dry areas or may result in boiling. Theoretical and experimental studies of falling films indicate that the flow rate beyond which no dry area may occur is a function of heating length and the wave amplitude of the liquid film. For lower flow rates, the heat flux required for the formation of a dry spot varies with film thickness and wave amplitude. On the other hand, if the conditions for the incipience of nucleate boiling are satisfied before a dry area forms, ebullition activity starts. If the activity is strong, a spray condition may result, which may also disrupt the film. Either mechanism will lead to the destruction of the film and permit a dry wall situation. (auth)

39258 BOILING BURNOUT HEAT FLUX MEASUREMENTS IN A NON-NEWTONIAN SUSPENSION. D. M. Eissenberg (Oak Ridge National Lab., Tenn.). New York, American Institute of Chemical Engineers, 1963, Preprint 20, 28p, $0.50. (CONF-225-3)

From American Institute of Chemical Engineers 51st National Meeting, San Juan, P. R., Sept.-Oct. 1963.

Prediction and correlation of the boiling burnout heat flux of thin stainless steel strips in non-Newtonian suspensions must take into account the effect of the yield stress upon the factors that determine the heat removal rate from a boiling surface. The results presented here indicate that for atmospheric pool boiling, a relatively low yield stress decreases the effectiveness of the bubble convection loop responsible for the subcooling effect. Higher yield stress slurries will disturb the thermal convection loop, which removes heat from the region around a heated surface in pool boiling, diminishing the effectiveness of subcooling still further. If the yield stresses are still higher, the slurry will also effect the process at the boiling surface, sharply reducing the saturation burnout heat flux. With forced convection, at atmospheric pressures, the reduction in burnout flux noted in the slurry was attributed to the loss in subcooling effect rather than to loss of the nonboiling forced convection heat transfer contribution. At intermediate pressures there was no difference between burnout fluxes in slurry and water since the subcooling effect itself became unimportant as the pressure increased. At pressures above about 500 psig, the reductions in the burnout flux in the

slurry were probably due to high yield stress resulting from accumulation of solids near the boiling surface. The accumulation can result simply from the loss of the bubble convection loop at the boiling surface at high pressures. (auth)

39259 ON THE APPLICATION OF THE SOURCE THEORY TO THE SOLUTION OF PROBLEMS INVOLVING PHASE CHANGE. PART I. GROWTH AND COLLAPSE OF BUBBLES. Wen-jei Yang and J. A. Clark (Univ. of Michigan, Ann Arbor). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-HT-14, 6p. (CONF-129-18)

From American Society of Mechanical Engineers, American Institute of Chemical Engineers 6th National Heat Transfer Conference and Exhibit, Boston, Aug. 1963.

By use of the source theory, approximate solutions are obtained for determining (a) the growth of a vapor bubble in pure liquids and binary liquid mixtures, and (b) the growth and collapse of a noncondensing, nonsoluble-gas bubble in a pure liquid. These approximate results for case (a) exhibit good agreement with the existing exact solutions. Case (b) may be applied to the injection of helium gas into liquid oxygen, a problem of current importance in cryogenic rocket systems. (auth)

39260 FILM BOILING ON A HORIZONTAL TUBE IN INCREASED GRAVITY FIELDS. M. L. Pomerantz (Bettis Atomic Power Lab., Pittsburgh). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-HT-17, 6p. (CONF-129-17; WAPD-T-1440)

From American Society of Mechanical Engineers, American Institute of Chemical Engineers 6th National Heat Transfer Conference and Exhibit, Boston, Aug. 1963.

The influence of acceleration on saturated pool film boiling from the outside of a horizontal 0.188-in. OD, stainless steel tube is reported. Freon-113 at approximately atmospheric pressure was used as the test liquid. Heat-transfer coefficients were determined for the experimental ranges: temperature differences of 200 to 500°F; heat fluxes of 5000 to 25000 Btu/hr-ft^2; and accelerations of 1 to 10 times normal acceleration. Data were correlated by adding a dimensionless parameter to the theoretical equation derived by Bromley for film boiling. High-speed motion pictures were taken from which interbubble distances, bubble periods, and bubble breakoff diameters were measured. (auth)

39261 MEASUREMENTS OF BURNOUT CONDITIONS FOR FLOW OF BOILING WATER IN A VERTICAL ANNULUS. K. M. Becker and G. Hernborg (Aktiebolaget Atomenergi, Studsvik, Tystberga, Sweden). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-HT-25, 12p. (CONF-129-16)

From American Society of Mechanical Engineers, American Institute of Chemical Engineers 6th National Heat Transfer Conference and Exhibit, Boston, Aug. 1963.

Measurements of burnout conditions are presented for flow of boiling water in an annulus with an inner diameter of 9.92 mm, an outer diameter of 17.42 mm, and a heated length of 608 mm. Data were obtained in respect of external heating only, internal heating only, and dual uniform and nonuniform heating. The following ranges of variables were studied and 978 burnout measurements were obtained.

Pressure	$8.5 < p < 37.5$ kg/cm^2
Inlet subcooling	$60 < \Delta t_{sub} < 205$ deg C
Steam quality	$0.10 < x < 0.91$
Inner surface heat flux	$0 < (q/A)_i < 303$ W/cm^2
Outer surface heat flux	$0 < (q/A)_o < 374$ W/cm^2
Mass velocity	$71 < \dot{m}/F < 961$ kg/m^2 sec

The results were compared with annuli and rod cluster data in published works, and a method for predicting burnout conditions in rod clusters is proposed. (auth)

39262 FRICTION AND HEAT-TRANSFER MEASUREMENTS TO TURBULENT PIPE FLOW OF WATER (Pr = 7 and 8) AT UNIFORM WALL HEAT FLUX. R. W. Allen (Univ. of Maryland, College Park) and E. R. G. Eckert. New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-HT-37, 10p. (CONF-129-12)

From American Society of Mechanical Engineers, American Institute of Chemical Engineers 6th National Heat Transfer Conference and Exhibit, Boston, Aug. 1963.

Measurements are reported of overall test section friction and of local heat transfer for the case in which hydrodynamically developed turbulent flow of water enters a uniformly heated circular tube. Systematic data are given for various heating rates and are shown to extrapolate to the zero heating rate or constant fluid property condition. In the thermal entrance region, variable property results are shown to agree with the measurements of Hartnett and constant property results are shown to agree with the analytical results of Sparrow, Hallman, and Siegel. Variable property test section friction results are shown to follow the wall temperature rule of Eagle and Ferguson. Constant property heat transfer results at Pr = 8 are shown to yield a Reynolds number exponent which increases systematically from 0.84 at Re = 15,000 to 0.87 at Re = 100,000. Nusselt numbers at Pr = 8 are in excellent agreement with the analytical results of Sparrow, Hallman, and Siegel. (auth)

39263 ESTIMATION OF STEADY-STATE STEAM VOID-FRACTION BY MEANS OF THE PRINCIPAL OF MINIMUM ENTROPY PRODUCTION. S. M. Zivi (Space Tech. Labs., Inc., Redondo Beach, Calif.). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-HT-16, 5p. (CONF-129-10)

From American Society of Mechanical Engineers, American Institute of Chemical Engineers 6th National Heat Transfer Conference and Exhibit, Boston, Aug. 1963.

An analysis of steam-void fraction in two-phase flow is carried out, utilizing the principle that in a steady-state thermodynamic process the rate of entropy production is minimum. The two-phase flow is idealized in the analysis to be a truly steady-state process. The effects of liquid entrainment and wall friction on the void fraction and slip ratio are evaluated. It is found that the slip-ratio in an idealized two-phase flow with zero wall friction and zero entrainment equals $(\rho_f/\rho_g)^{1/3}$. Data from a number of experiments are found to be bracketed between this result and the result obtained by assuming complete entrainment (slip ratio = 1). (auth)

Materials Testing

39264 (HW-71570) AUTOMATIC PROCESSING OF TENSILE TEST DATA. A. L. Bement, Jr. and L. D. Coffin (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 1963. Contract AT (45-1)-1350. 40p.

An approach is described for automatically processing tensile-test data on a high-speed electronic computer. A program is developed in Fortran language for use with the IBM 7090 computer. The program can be generalized for use with several testing schemes if the tests are conducted at a constant strain rate. (D.L.C.)

39265 X-RAY-DIFFRACTION PHASE ANALYSIS OF METALS AT HIGH TEMPERATURES. Peter Skulari. Kohasz. Lapok, 95: No. 1, 40-5(1962).

Information is given on measurements in a special chamber of the integrated intensity of two diffraction lines with the use of two Geiger-Muller counters. In quantitative phase analyses of the steel and Ti the specimen under investigation of 12 × 20 × 3 mm in size was heated within some seconds to 1000–1500°C by direct passage of 100 amps current. The temperature was measured with two Pt/Pt-Rh thermocouples. A vacuum of $1.10^{-5} - 1.10^{-6}$ mm Hg was produced in the chamber. With the use of this chamber studies can be performed on: quantitative phase analysis of steel and alloys in a wide temperature range; analysis of diagrams of stable and metastable states; investigation of metal transition points from one phase condition to another; and investigation of quenching and tempering processes during heating and cooling. The chamber can also be used to investigate Ti and its alloys. (OTS)

GEOLOGY, MINERALOGY, AND METEOROLOGY

Refer also to abstract 39188.

39266 (HNS-17) RADIOCHEMICAL FALLOUT STUDY OF A PACIFIC CYCLONIC STORM. Paul Kruger and Albert Miller (Hazleton-Nuclear Science Corp., Palo Alto, Calif.). May 31, 1963. Contract AT(04-3)-457. 32p.

A detailed meteorological and radiochemical analysis was completed for the storm occurring on February 7, 1962, at Santa Barbara, California. Continuous collections of precipitation were made at altitudes of sea level, 2000, and 4000 feet. The sampling period straddled three large-scale events: (1) the approach toward the coast of a cyclone, which reached its peak intensity shortly after 1100 PST and then declined in strength as it drifted slowly northward off the Oregon and Washington coast; (2) the passage of the upper-level trough at 500 mb at about 1600 PST; and (3) the approach of a second wave late in the period. The three sites exhibited similar Sr^{90} deposition patterns. Concentrations ranged from over 100 dpm/liter to less than 1 dpm/liter with several changes of over a factor of ten within hourly periods. The large variations of the Sr^{90} concentration in the precipitation at the three altitudes were linked to the atmospheric changes during the storm with the aid of a detailed vertical time section. Observations are made of the effects of saturation of the lower layers of air, the overturning of the marine layer, the approaches of the frontal and upper trough zones, the gradual vertical growth of the cloud system up to the tropopause, and the incursions of high-level layers of dry air. (auth)

39267 (HNS-24) RADIOACTIVE FALLOUT IN CONVECTIVE SHOWER PRECIPITATION. Progress Report. Paul Kruger, D. Ray Booker, Larry G. Davis, and Charles L. Hosler (Hazleton-Nuclear Science Corp., Palo Alto, Calif.). June 30, 1963. Contract AT(04-3)-457. 48p.

During 1962, three collections of precipitation from convective storms over Pennsylvania were made. Detailed meteorological and radiochemical analyses of these storms were prepared to evaluate the effects of convective activity upon Sr^{90} deposition by precipitation and to compare these effects to those noted for the convective storms studied in 1961. The data confirm the observations made earlier in relating the peak Sr^{90} concentration in developing cells to the maximum height of the cloud tops relative to the height of the tropopause and the distance from the cells to the jet stream. The peak concentrations in the 1962 collections were about a factor of forty greater than those in 1961. The effects of the relative distance of the cell centers with respect to the collection site and the effects of evaporation below the cloud bases also were noted. Cells whose centers pass directly over the collection site show marked Sr^{90} concentration increases associated with downdrafts and cell development, and cells whose peripheries pass over the collection site show Sr^{90} concentration decreases initially due to lessening evaporation effects followed by increases due to further cell development. (auth)

39268 (ORO-599) DEPOSITION AND WASHOUT COMPUTATIONS BASED ON THE GENERALIZED GAUSSIAN PLUME MODEL. Walter M. Culkowski (Weather Bureau, Oak Ridge, Tenn.). Sept. 30, 1963. 27p.

Calculations of the washout and surface deposition of effluent, based on dispersion parameters in the literature, are presented. Maximum rates of deposition and washout for any given release are established. Washout appears to be the principal factor in maximizing surface contamination. Dry deposition is more likely to occur than washout. (auth)

39269 (TID-19483) JOINT INDO-UNITED STATES BALLOON FLIGHT PROGRAM — 1961. Research Report. Charles W. Chagnon, ed. (Air Force Cambridge Research Labs., Laurence G. Hanscom Field, Bedford, Mass.). Dec. 1962. Contract AT(49-7)-1431. 207p. (AFCRL-62-1135)

The Joint Indo-U.S. Balloon Flight Program was conducted at Hyderabad, India, from February through April, 1961. A complete report of all phases of this international, cooperative effort is presented, including the details of the balloon flight operations, the preliminary scientific results achieved, and an evaluation of the overall accomplishments of the program. In addition to the contribution of heretofore unavailable data on the equatorial stratosphere, the operational success of the program demonstrated the feasibility of performing recoverable high-altitude balloon flights in the tropical latitudes. (auth)

39270 (UCRL-13074) LABORATORY STUDIES OF THE RADIOACTIVE CONTAMINATION OF AQUIFERS. Melvin C. Schroeder and A. Ray Jennings (Texas. Agricultural and Mechanical Coll., College Station. Research Foundation and Texas. Agricultural and Mechanical Coll., College Station. Engineering Experiment Station). June 28, 1963. For Univ. of California Lawrence Radiation Lab., Livermore. Contract W-7405-eng-48. 120p.

Exchange column experiments and batch determinations of the distribution coefficient were utilized in studying the migration of radioactive cesium and strontium through earth materials. The studies indicate that the prediction of the rate of movement of these two radioisotopes in relation to the rate of ground-water movement can be made with reasonable accuracy. Several factors affect the transport of radioactive substances by water through granular earth materials. The distribution coefficient is probably the single-most important factor. The distribution coefficient for a mineral or material is a measure of the adsorption of an ionic species. This coefficient is dependent on the ion concentration, the chemical nature of the material, the surface area of the material, the nature of the competing ions in the water, their concentration, and the pH of the solution. Other factors affecting the movement of radioactivity through granular material are the rate of uptake of the activity by the mineral, the rate of elution of the adsorbed radioactivity, the velocity of the water, hydraulic dispersion in a longitudinal direction, and the dispersion in a lateral direction. The latter, however, is not of importance in column experiments. Distribution coefficients were determined by the batch method for cesium and strontium for the 20–30 and 50–60 mesh sizes of quartz sand, crushed quartz, and crushed microcline for several concentrations of either sodium, potassium, or calcium. Coefficients were determined for some other minerals such as calcite, soda feldspar, and limestone. Exchange column experiments were done using the previously stated two sizes of quartz sand, crushed quartz, and crushed microcline. These experiments have used various concentrations of calcium, potassium, and sodium as the competing or eluting cation. An isotope pulse was placed

on the minerals in the columns and eluted at flow rates of 10 cm or 1 cm per hour. The distribution coefficient can be determined from the column elution history by the Mayer and Tompkins equations. However, this calculation was made using the position of 50 percent elution of the activity from the column instead of the peak position of the radioactivity. Discrepancies between the batch and column coefficients for the same materials and solutions are of small magnitude. Therefore, the equation derived by Higgins in 1959 can be used to determine the rate of migration of tracer concentrations of radioisotopes. This states that the average velocity of a radioactive ion is equal to the velocity of the transporting water divided by the sum of one plus the product of the distribution coefficient (batch) and the exchange ratio, which is defined as the bulk density divided by the porosity. Batch distribution coefficient determinations can be used to predict with reasonable accuracy the migration of radioactivity from the site of a nuclear explosion used for excavation or other purposes. The coefficient must be for the material through which the transporting water is moving. The flow rate of groundwater in the aquifer and its physical properties such as bulk density and porosity must be known. The nature of the pypothetical average aquifer and the pre-explosion site investigation will insure that there will be no hazards related to radiological contamination of ground water. (auth)

39271 (AEC-tr-6022) DETERMINATION OF THE AGE OF FISSION PRODUCTS ACCORDING TO THE CHANGE IN TOTAL AREA OF THE PHOTOPEAK OF $Zr^{95} + Nb^{95}$ WITH TIME. Z. G. Gritchenko. Translated from report A/AC.82/G/L.847. [1962]. 9p.

Expressions are derived for determining the age of fission products by measuring the decrease in area of the total photopeak of Zr^{95} and Nb^{95}, as obtained with a scintillation gamma spectrometer. Additional relations by which the content of Zr^{95} and Nb^{95} can be determined from the measured ages and the ratio of their activities are also established. A procedure for determining the ratio in radioactive fallout fission products of the Zr^{95} formed in previous atomic tests to the Zr^{95} formed in current tests is demonstrated. (D.C.W.)

39272 RADIOACTIVITY OF THE SILICEOUS BLACK SHALES AT NAGARJUNASAGAR DAM SITE, ANDHRA PRADESH. P. S. N. Murty (Andhra Univ., Waltair, India). Current Sci. (India), 32: 73-4(Feb. 1963).

An analysis of the beta activity and the K, U, noncarbonate C, S, and Si contents shows that: the activity bears a fairly direct relation to the K, U, S, and C contents; the activity is inversely related to the Si content; and the U/K ratio is not constant, perhaps due to the absence of sustained reducing environment. Potassium seems to be the most likely contributor to the high activity observed. (D.C.W.)

39273 A PRELIMINARY NOTE ON THE OCCURRENCE OF A RADIOACTIVE UPPER VINDHYAN PELITIC SANDSTONE. S. Viswanathan (Dept. of Atomic Energy, New Delhi, India). Current Sci. (India), 32: 120-1(Mar. 1963).

A pelitic sandstone displaying a radioactivity up to 12 times the background radiation was discovered within the Rewa Santstone of the Vindhyan formations of India. The rock, a fissile, fine-grained, banded sandstone of subordinate pelitic composition, has assayed up to 0.160% equivalent U_3O_8 radiometrically, and 0.03% U_3O_8 chemically. The pelitic cementing matrix apparently contributes most of the radioactivity of the rock, which seems to contain sediments from the Bundlekhand Granites to the east. (D.C.W.)

39274 RAYLEIGH WAVE TRANSMISSION ON ELASTIC WEDGES. J. Kane and J. Spence (Univ. of Rhode Island, Kingston). Geophysics, 28: 715-23(Oct. 1963).

A method is introduced by which transmission or conversion coefficients can readily be calculated for surface-wave diffraction at crustal discontinuities that can be idealized as wedge-shaped obstacles. The method, an iteration procedure, is illustrated by an application to Rayleigh-wave propagation on elastic wedges with free boundaries. It is shown that the leading term of the iteration procedure yields an expression for the transmission coefficient that matches the experimental data for a range of wedge angles that includes the crustal wedges commonly found in seismic practice. Numerical data are presented that illustrate the transmission coefficient's variation in terms of Poisson's ratio and the wedge angle. (auth)

39275 MOVEMENT OF RUTHENIUM IN THE BED OF WHITE OAK LAKE. T. F. Lomenick (Oak Ridge National Lab., Tenn.). Health Phys., 9: 835-45(Aug. 1963).

Currently, a few thousand c/year of ruthenium flow onto the bed of former White Oak Lake from the Oak Ridge National Laboratory's intermediate-level waste pits. As the waste water traverses the lake bed a significant portion of the ruthenium is removed from solution. The ruthenium that is not sorbed on the lake-bed soil drains into White Oak Creek, a tributary of the Clinch River. An investigation was made to determine the quantity and distribution of ruthenium in the soil of the lake bed and to identify and define geohydrological factors affecting the movement of ruthenium through the lake bed. As of February 1962, the lake bed contained approximately 1200 c of ruthenium. The ruthenium is present mainly in two tracts of contamination, covering approximately 10 acres, that coincide roughly with the surface flow of waste over the bed. The highest concentrations of ruthenium occur in the uppermost few in. of the lake bed and about 70 per cent of the activity is in the top 2 ft of soil. The lake bed is underlain by a thin layer of recent lacustrine sediment, several ft of alluvium and the Conasauga shale formation of Cambrian age. Water-level measurements indicate that the depth to ground water varies from <1 to 5 ft below the surface. The subsurface migration of ruthenium follows closely the paths indicated by water-table contours. The rate of ground water movement in the upper 2 ft of soil varies from 1 to 5 ft/day, while movement in the material 2–5 ft below the surface ranges from 0.05 to 0.25 ft/day. Thus, the maximum rate at which ruthenium may travel in the upper layers of soil is approximately twenty times that of the lower layers. Ruthenium is transported to White Oak Creek by surface water and ground water moving over and through the bed of White Oak Lake. Only a small fraction of the ruthenium is transported by ground water through the lake-bed soil into the creek. The ruthenium moves at such a slow rate through the soil that radioactive decay reduces the concentration of that reaching the creek by subsurface movement to insignificant proportions. The amount of surface flow and, consequently, the quantity of ruthenium that reaches the creek from the lake bed varies seasonally. During the dry summer months drainage from the waste pits recharges the ground water in the lake bed and thus there is little surface flow and, consequently, little ruthenium that flows into White Oak Creek. However, in the wet winter season surface runoff from the lake bed is high and therefore larger amounts of ruthenium enter White Oak Creek. (auth)

39276 GEOLOGY AND ABSOLUTE GEOLOGICAL TIME. Pu Li. Kexue Tongbao, No. 10, 16-26(Oct. 1962). (In Chinese)

The application of natural radioactivity to the determination of the age of rocks is reviewed from several points of view. The history of the development of the method which is subdivided into the exploratory period, the refinement of the method, and its systematic applications is discussed. The applicability of the various currently used methods is described, considering the time of the formation of the sample rocks within a relatively short range of the geological time, the decay constant of the mother element of the stable daughter elements, the abundance of the mother element together with its isotopic ratio, the precision of the chemical or physical analytical method used, and the possible loss or gain in the concentration of the mother element after the formation of the rock is completed. The appropriate mother elements and their daughters are tabulated, giving the decay mechanism and the most important physical constants. Examples are given on the age determination of rocks from various areas, using the Pb^{206}/U^{238}, Pb^{207}/U^{235}, Pb^{206}/Pb^{207}, Pb^{208}/Th^{232}, K^{40}/Ar^{40}, and Rb^{87}/Sr^{87} ratios in the samples. The application of the precisely determined geological ages to the interpretation of the rock formation mechanisms is discussed, using the history of various pre-Cambrian formations on the basis of A. A. Polkanov's work on the Baltic area, A. P. Vinogradov and N. P. Semenenko's studies on Ukrainian formations, A. Holmes's investigations on South African rocks, G. Gastil's studies on North American rocks, and M. S. Krishnan's data on Indian deposits as an illustration of the theory. Additional examples include work of D. Greenhalgh et al. on Australian rocks and A. E. Togarinov's studies on Chinese rocks. An attempt is made to correlate the data with the periodic upheavals of the earth's crust. (TTT)

39277 A NEW CALCULATION FOR THE AGE OF THE EARTH FROM ABUNDANCES OF LEAD ISOTOPES. R. G. Ostic (Univ. of British Columbia, Vancouver), R. D. Russell, and P. H. Reynolds. Nature, 199: 1150-2(Sept. 21, 1963).

A new method, basically distinct from the two most common methods, is suggested for calculating the age of the Earth from lead isotope abundances. In common with other methods, the new method assumes that the samples used in the calculation can be interpreted by equations appropriate to evolution of the lead isotope abundances in a single closed system. It does not however, require estimates to be made for any of the ages of the samples used, and it does not require the assumption that the age of the Earth is the same as the age of meteorites. It does assume that terrestrial leads have evolved in the Earth from lead similar in isotopic composition to that in the troilite phase of iron meteorites, and in fact the method provides an estimate for the time at which the Earth's lead had this isotopic composition. Results of 4.53 ± 0.03 and 4.54 ± 0.02 Gyr were obtained. (P.C.H.)

39278 THE LOSS OF STRONTIUM^{90} FROM SMALL CULTIVATED WATERSHEDS. Maurice H. Frere and Howard Roberts, Jr. Soil Sci. Soc. Am. Proc., 27: 82-3 (Jan.-Feb. 1963).

Soil samples were taken from the plow layer of eight small watersheds and analyzed for Sr^{90}. Two watersheds in permanent pasture, with no recorded loss soil, contained about 90 mc per square mile, which is slightly higher than an estimated total deposit at the time of sampling. The plow layer of six watersheds under cultivation was sampled by compositing soil cores taken on contours of each watershed. The Sr^{90} concentration of the samples was from one-third to two-thirds of that in the permanent pastures. The loss of Sr^{90} appeared to be influenced by length of slope and cropping history. No areas of Sr^{90} accumulation were found within the watersheds. (auth)

39279 THE LEACHING OF RADIOSTRONTIUM AND RADIOCESIUM THROUGH SOILS. J. R. Miller and R. F. Reitemeier (Dept. of Agriculture, Beltsville, Md.). Soil Sci. Soc. Am. Proc., 27: 141-4(Mar.-Apr. 1963).

Experiments were conducted in a greenhouse to determine the downward movement of Cs^{137} and Sr^{90} in soils under intensive leaching. The five soils (Norfolk, Hagerstown, Miami, Fort Collins, and Huntley series) selected for the investigation represented a wide range of soil properties, and the leaching treatments consisted of 30 and 300 in. of deionized water, 0.005N NaCl, and 0.005N $CaCl_2$. There was little downward movement of Cs^{134} when the soils received the applications of deionized water, NaCl, or $CaCl_2$. Radioactive assays of the soil columns showed that 99.6 to 100% of the Cs^{134} was in the surface two layers of the soil columns (average depth 1.4 inches) after 300 inches of leaching. In the leaching experiment with Sr, the $CaCl_2$ produced the greatest movement of Sr^{89} and deionized water the least. The maximum distance Sr^{89} penetrated into the soils when leached with 30 inches of water was 1.3 inches, and with 300 inches of water the distance was 4.3 inches. In general, there was more movement of Sr^{89} in the Norfolk soil and least in the Huntley, with the other soils being intermediate. (auth)

39280 DIFFUSION THEORY APPLIED TO WATER FLOW DATA OBTAINED USING GAMMA RAY ABSORPTION. Hayden Ferguson and Walter H. Gardner (Washington Agriculture Experimentation Station, Pullman). Soil Sci. Soc. Am. Proc., 27: 243-6(May-June 1963).

Unsaturated water flow data obtained using gamma ray equipment were not fit by the equation $x = 2\eta(\theta)t^{1/2}$. Thus, the data could not be used in the ordinary differential equation obtained by combination of $x = 2\eta(\theta)t^{1/2}$ and the second-order differential equation of diffusion. The discrepancy between the data and $x = 2\eta(\theta)t^{1/2}$ was not great over much of the range; thus, it is possible that the equation could be used in much unsaturated flow work. The data did indicate that diffusivity was a function of water content alone over much of the time of water flow. The relationship between diffusivity and water content followed a nonexponential, curvilinear relationship. The data also suggest that a minimum gradient may be essential in order for unsaturated flow to occur. (auth)

39281 DIFFUSION OF TRITIATED WATER IN SOILS. F. S. Nakayama and R. D. Jackson (Water Conservation Lab., Tempe, Ariz.). Soil Sci. Soc. Am. Proc., 27: 255-8 (May-June 1963).

The apparent diffusion coefficient of tritiated water (D_{THO}) was measured in four soil materials and two sizes of glass beads at about 40% water content by volume, and in agar gel. The apparent tritiated water diffusion coefficient may include diffusion in the liquid, vapor, and possibly adsorbed phases. For Pachappa loam, D_{THO} was determined in detail as a function of water content. The D_{THO} was nearly constant for volumetric water contents of 10 to 40%. As the water content decreased below 10%, the D_{THO} rapidly increased to a maximum at about 4% water content, then rapidly decreased as the water content was further reduced. The maximum value of D_{THO} is 3.5 times greater than D_{THO} at 40% water content. (auth)

39282 A BLAST-WAVE THEORY OF CRATER FORMATION IN SEMI-INFINITE TARGETS. William J. Rae and Henry P. Kirchner (Cornell Aeronautical Lab., Inc., Buffalo). 65p. (CONF-192-1)

From 6th Hypervelocity Impact Symposium, Cleveland, Apr.-May 1963.

An analytic formulation of the problem of crater formation is presented, using the methods of blast-wave theory. The approximations on which this approach is based are chiefly concerned with the self-similar, or progressing-wave nature of the solution, with the type of state equation used, and with the extent to which the conservation of energy and momentum can be fulfilled. These approximations and the limitations which they impose are reviewed, particularly as applied to the problem of shock propagation in solids. Neglect of momentum conservation is shown to be a good approximation, but use of the Mie-Grüneisen equation of state is found to be largely incompatible with the assumption of similarity. An approximate nonsimilar solution for impact-generated shock propagation is derived, and displays excellent agreement with observed shock-wave trajectories. To derive a penetration law from any solution, some point in the trajectory must be chosen as the crater radius. The strong influence of this choice on the penetration law is discussed, and it is argued that the target strength should play a role in its determination. A simple choice of the crater-formation criterion, related to the intrinsic shear strength of the target, is utilized in conjunction with the nonsimilar solution, to derive a penetration law which correlates a large amount of data. (auth)

HEALTH AND SAFETY

Refer also to abstracts 38732, 39198, and 40277.

39283 (AHSB(RP)R-26) ENVIRONMENTAL MONITORING IN RELATION TO GASEOUS DISCHARGES FROM U.K.A.E.A. ESTABLISHMENTS. R. J. Garner (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch. Radiological Protection Div., Harwell, Berks, England). Aug. 1963. 11p.

The primary objective of an environmental monitoring program conducted for statutory purposes is to establish that the radiation exposure of the general public does not exceed specified limits. Measurements intended to achieve this objective should therefore be capable of being related to these limits. Since in most cases the dominant potential hazard from gaseous discharges is ingestion of contaminated food, adequate control can be effected by identifying the critical foods and critical nuclides for any particular situation. Sampling is then largely confined to specific items of the diet (usually milk) and analysis to determination of individual nuclides. These basic principles are developed and examples are given of their application to UKAEA establishments. (auth)

39284 (ANL-6765) A STUDY OF THE CORRELATION BETWEEN HAND AND WRIST EXPOSURES. W. E. Bleiler and W. B. Grant (Argonne National Lab., Ill.). Aug. 1963. Contract W-31-109-eng-38. 8p.

Measurements were made of radiation exposures to the hand and wrist from a 41-g Pu source. A plaster hand with film badges attached at several locations was used in the measurements. A ratio of 4 : 1 in determining the exposure of hand and wrist by large radiation sources was estimated to allow for a safety factor of about 2. Small sources held directly on the hand resulted in a greater exposure. (C.H.)

39285 (AWRE-0-67/63) THE DEVELOPMENT AND COMPATIBILITY OF A HANDLING LACQUER FOR USE ON URANIUM. S. Orman and P. Walker (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Sept. 1963. 18p.

A handling lacquer has been developed for use on uranium metal which effectively minimises contamination of personnel and equipment during experimentation. Experimental usage over a period of two years has shown that this lacquer has good impact and abrasion resistance and a minimum tendency to flake from sharp edges. Dyes and leafing aluminum powder may be added to aid application of specified film thicknesses and to act as a color code. The lacquer is compatible with uranium and the addition of leafing aluminum powder confers slight protective properties at temperatures below 40°C. The lacquer has been found suitable for use on beryllium. (auth)

39286 (EUR-407.f) STATION MOBILE DE DECONTAMINATION DES PERSONNES. (Mobile Decontamination Unit of Persons). M. Collet, L. Musso, and P. Recht (European Atomic Energy Community). 1963. 26p.

A mobile decontamination unit is described. The vehicle was constructed for swift and effective action at any point in Europe at which a nuclear incident may occur. A description is also given of the equipment designed for the decontamination of persons, and details are given of the unit's ability to operate for long periods without refuelling. (P.C.H.)

39287 (HASL-140) FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, JUNE 1, 1963–SEPTEMBER 1, 1963. Edward P. Hardy, Jr., Joseph Rivera, and William R. Collins, Jr. (New York Operations Office. Health and Safety Lab., AEC). Oct. 1, 1963. 321p.

Current data are presented from the HASL Fallout Program, the New Zealand Department of Scientific and Industrial Research, and the Dominion X-Ray and Radium Laboratory in New Zealand. Radionuclide levels in fallout, milk, tap water, diet, and upper air samples are given in tabular form. Also included are interpretive reports and notes dealing with worldwide fallout levels through 1962, measurements of fallout γ radiation, statistical studies of fallout vs frequency of precipitation and optimum sample sizes for fallout surveys, Sr^{90} levels in the 1962 wheat crop and milling products, stable Sr concentrations in three bones of the human skeleton, and quality control data for HASL and other laboratories for the preceding year and a half. A bibliography of recent literature pertinent to fallout studies is included. (auth)

39288 (HW-76351(Rev.)) PROTECTIVE CLOTHING MONITORING SYSTEM. M. O. Rankin and W. G. Spear (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 1, 1963. Contract AT(45-1)-1350. 22p.

An automatic conveyor-type laundry monitoring system, which monitors laboratory coats and coveralls for both alpha and beta-gamma contamination, was developed and installed at the Hanford Laundry Facility to improve monitoring efficiency and control. The instrument employs eight alpha and seven beta-gamma scintillation large-area detectors, a garment conveyor, solid state circuitry, and appropriate signaling devices. Garments are manually placed on hangers which are then placed onto an automatic loading mechanism. Each garment is conveyed past detectors where it is monitored for beta-gamma and alpha contamination. Contaminated garments are rejected and dropped into a special container if spot contamination exceeds 1000 disintegrations per minute (dis/min) of alpha or 5000 dis/min of mixed fission products. The garments which are not rejected pass through for folding and distribution. The system, which requires only one attendant, can effectively monitor 500 garments per standard shift. System operation was fully successful for ten months. (auth)

39289 (NAA-SR-Memo-8915) NUCLEAR SAFETY CRITERIA [FOR] U^{233}–ALLOY FUEL FABRICATION. Norman Ketzlach (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 22, 1963. Contract [AT(11-1)-Gen-8]. 8p.

Safety criteria are presented for the handling of U^{233} in finely divided fuel, unmoderated U^{233} fuel systems, and water. These criteria are compared with those for U^{235} fuels. It is estimated that the maximum safe batch size of contained U^{233} is $\frac{1}{3}$ to $\frac{1}{2}$ that for the corresponding U^{235} fuels, depending on the fuel form, size, and degree of water moderation and reflection. For finely divided systems of fuel and water, the maximum safe batch size for U^{233} is 250 g compared to 350 g for U^{235} fuels. It is stressed that all fuel-handling operations, in which unclad fuel is involved, should be conducted in hoods. (C.H.)

39290 (NAVDOCKS-P-290) STUDIES IN ATOMIC DEFENSE ENGINEERING. (Bureau of Yards and Docks). Revised June 1962. 335p.

Engineering information is summarized for shelters to protect against the effects of nuclear explosions. Group, family, and emergency-type shelters are considered. Structural materials, shielding requirements, ventilation equipment, electrical equipment, water supplies, the protective effects of conventional structures and various shelter designs, blast protection, fire protection, fallout protection, and the psychological effects of shelter occupation are discussed. Protection against chemical and biological warfare agents is also discussed briefly. (C.H.)

39291 (NP-13087) DESIGN OF OPENINGS FOR BURIED SHELTERS. Report No. 2-67. (Newmark (Nathan M.), Urbana, Ill.). July 1963. Contract DA-22-079-eng-225. 329p.

Design features and structural and mechanical parameters of entrance structures for buried shelters are discussed. Criteria include low-cost protection against blast and associated thermal and nuclear radiation from a 1-MT nuclear weapon. Interactions between shelter entrance and various other shelter systems are considered. Topics discussed in detail include basic design considerations, shelter entrance systems, ventilation systems, effects input data, radiation shielding design parameters, blast design parameters, design procedures, and illustrative examples. (C.H.)

39292 (NP-13118) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 1, No. 8. (Canada. Dept. of National Health and Welfare, Ottawa). Aug. 1963. 44p.

Data are presented on fallout radioactivity in samples of fresh milk and air filters analyzed during July 1963, and Sr^{90} in bone samples analyzed during 1962. Results are included from environmental monitoring of the Chalk River area and users of radioisotopes. Data on radiation doses recorded on film badges worn by workers using γ- or x-ray sources are summarized. (C.H.)

39293 (NP-13151) EVALUATION OF WATER CONTAMINATION FROM FALLOUT. Final Technical Report, May 9, 1962–July 31, 1963. W. N. Grune, T. F. Craft, Jr., and W. M. Sloan (Georgia Inst. of Tech., Atlanta. Engineering Experimental Station). Contract OCD-OS-62-189. 205p.

Available information is summarized on the contamination of water supplies by radioactive fallout in the event of nuclear war. A model for nuclear attack and fallout is used to estimate possible levels of contamination by selected isotopes in the water supply of Houston, Texas and New York City. The biological uptake and resultant body burdens in man are evaluated in relation to the levels of water contamination considered likely. Procedures are outlined for the post-attack monitoring of water supplies and decontamination procedures are discussed. A computer program is included for estimating sublimation pressure for surface burst nuclear explosions. With appropriate consideration to the assumptions made, the results may be applied to the watersheds of municipalities other than those shown. (C.H.)

39294 (ORNL-3490) APPLIED HEALTH PHYSICS ANNUAL REPORT FOR 1962. J. C. Hart, ed. (Oak Ridge National Lab., Tenn.). Oct. 2, 1963. Contract [W-7405-eng-26]. 79p.

The environmental monitoring data processed during 1962 indicated that Laboratory operations did not contribute appreciably to the contamination of the environment with radioactive materials. However, the effects of airborne radioactive materials generated from nuclear weapons tests conducted at various locations throughout the world continued to be reflected in certain parts of the environmental monitoring data. The concentration of radioactive materials in air (as determined by air filtration techniques) increased by a factor of about 2.5. The concentration of radioactive materials in rain water increased by a factor of 3 to 5. The Sr^{90} concentration in raw milk increased by a factor of about 3. The I^{131} concentration in raw milk increased by a factor of about 12. The general radiation background increased by a factor of 2 in the East Tennessee Area. Gamma measurements taken over river bottom sediment increased by a factor of about 2 in Fort Loudoun Reservoir, a body of water that is fed by the Tennessee River and not affected by liquid waste releases originating from Oak Ridge operations. The calculated average concentration of radioactive materials in the Clinch River resulting from waste releases originating from ORNL operations decreased from 18% of the $(MPC)_w$ in 1961 to 7.4% of the $(MPC)_w$ in 1962. The measured concentration at a point about 16 miles below the entry of ORNL waste releases averaged 4.9% of the $(MPC)_w$ during 1962. There were no personnel exposures recorded during 1962 which exceeded maximum permissible levels. The highest total body dose recorded was 4.6 rem which is 38% of the maximum permissible annual dose. There were no cases involved where the internal deposition of radioactive material in the body was estimated to have exceeded one-half of a maximum permissible body burden averaged over a 12-month period. As of December 31, 1962, only one individual had accumulated a total body dose from external radiation which exceeded the age proration formula 5(N-18). The Laboratory experienced 55 unusual occurrences during 1962, all of which were classified as minor events. Both the frequency rate and severity index of unusual occurrences continued to drop during 1962. (auth)

39295 (ORNL-3492) HEALTH PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1963. (Oak Ridge National Lab., Tenn.). Sept. 30, 1963. Contract W-7405-eng-26. 245p.

Progress in health physics is reported under 20 topics. Separate abstracts were prepared for 19 topics. Education, training, and consultation are also discussed. (M.C.G.)

39296 (ORNL-3492(p.3-12)) LIQUID INJECTION INTO DEEP PERMEABLE FORMATIONS. D. G. Jacobs, O. M. Sealand, and O. H. Myers (Oak Ridge National Lab., Tenn.).

The Ca–Sr exchange properties of numerous minerals show that these two cations behave quite similarly in ion exchange reactions. In cases where precipitation of slightly soluble salts occurs, the relative behavior may differ appreciably; strontium is less likely to be removed from solution than calcium by calcium carbonate but more likely to be removed by phosphatic minerals. Solution dispersion due to formation heterogeneities is likely to lead to radionuclide dispersion a few orders of magnitude greater than that observed in laboratory columns. As a result, the factors affecting dispersion in laboratory columns are likely to be of little influence in affecting radionuclide dispersion in the environment. In order to study geometric effects of dispersion of radionuclides by porous media and to test the effectiveness of physical and chemical barriers on a laboratory scale, a sandstone model was constructed. The kinetics of ion exchange reactions observed in linear-flow columns will be extrapolated to the two-dimensional flow system, and the calculated response compared to measured values. (auth)

39297 (ORNL-3492(p.13-18)) DISPOSAL BY HYDRAULIC FRACTURING. Wallace de Laguna, Tsuneo Tamura,

R. C. Sexton, H. O. Weeren, E. G. Struxness, F. S. Brinkley, and B. L. Houser (Oak Ridge National Lab., Tenn.).

An acceptable waste mix was developed that is usable with waste solutions having a wide range of concentrations and chemical compositions. It is probable that an equally acceptable, cheaper mix can be developed that will require less of the expensive fluid-loss additive. An injection and an observation well were drilled, logged, cased, and cemented. These wells are 1080 ft deep; the main casing string of the injection well is 5.5 in. OD, and the main casing string of the observation well is 2.875 in. OD. The design of the injection plant is virtually complete. The equipment consists of waste storage tanks, a waste transfer pump, four bulk storage tanks to store the solid constituents of the mix, a jet mixer, a high-pressure injection pump, and a standby injection pump and mixer. The mixer, injection pump, and wellhead valving will be installed in cells to reduce radiation exposure and limit the area of possible contamination. In the proposed experiments several 40,000-gal batches of intermediate-level waste solution will be mixed with cement and injected into a shale formation at an approximate depth of 900 ft. At some time after the completion of the third injection the formation will be core drilled to verify the location of the grout sheets and to evaluate the various mixes. (auth)

39298 (ORNL-3492(p.19-37)) DISPOSAL IN NATURAL SALT FORMATIONS. J. O. Blomeke, W. J. Boegly, Jr., R. L. Bradshaw, et al. (Oak Ridge National Lab., Tenn.).

A 2-ft-high by 8-ft-wide model room was cut into a pillar to a depth of 10 ft, and closure rates were measured both before and during heating of the room to 160°C. The floor-to-ceiling closure rate after 40 days of heating (5×10^{-3} in./day) was two orders of magnitude higher than that at ambient temperature. Continued flow at this rate would completely close the room in 12 yr. Measurements of creep closure in the Hutchinson, Kansas, mine in rooms ranging in age from about 1 to 27 yr indicated that closure rates decrease with age but increase with increased salt extraction. The floor-to-ceiling closure rates range from 8×10^{-4} to 1×10^{-4} in./day. A demonstration of disposal of high-level radioactive waste solids is being designed for the Carey Salt Company Mine in Lyons, Kansas. The purposes of the demonstration are to perfect equipment and techniques and to investigate the synergistic effects of heat, radiation, and pressure on plastic flow, salt stability, and chlorine production. The demonstration consists of a seven-can array of fuel assemblies, an electrical-heat-equivalent array, and two sets of electrical heaters to heat a pillar between the two arrays. Fourteen irradiated Engineering Test Reactor fuel assemblies will provide radiation in lieu of actual solidified waste. The test will last 2 yr; then all fuel assemblies will be returned to the Idaho Chemical Processing Plant for recovery of unfissioned fuel. High-temperature studies on the disposal of high-level solid wastes were continued. In tests with 6-in.-dia by 4-ft-long heat sources (in 10-in.-dia by 10-ft-deep holes in the floor and wall), the effects of salt temperatures up to 350°C were investigated. Shattering of salt in situ in the Hutchinson mine occurred at about 280°C, in comparison to a range of 260 to 320°C determined from samples in the laboratory. Maximum reduction in hole diameter was 15%, due to nonrecoverable thermal expansion at a salt temperature of 350°C. Nonrecoverable expansion of about 0.5 in. of the floor and wall around the holes was also observed. Experimental work on KCl was used to calculate total production of chlorine in irradiated NaCl. After 200 days, a total of 0.5 mole of oxidizing agent would be produced per 6-in.-dia by 12-ft-long can of hypothetical (expected to be produced about 1975) solid waste. Irradiation of NaCl indicated that these values are conservative and that for short-term storage of high-level wastes in salt, little or no production of free chlorine can be expected. Creep measurements in the Hutchinson mine indicated that the greater the per cent of extraction, the greater the creep, and the older the age of the excavation, the lower the creep, with an average closure rate of 5×10^{-4} in./day. Cores taken from the floor and roof of the Lyons mine showed that the only extensive pure salt deposits in the formation are those currently being mined. Therefore it was concluded that the experiment should be in the same salt bed previously mined. (auth)

39299 (ORNL-3492(p.37-50)) CLINCH RIVER STUDY. N. J. Ackermann, Jr., W. P. Bonner, P. H. Carrigan, Jr., et al. (Oak Ridge National Lab., Tenn.).

Results from the first year's water-sampling program indicated that most of the radioactive material entering the Clinch River from ORNL passes out of the river system in the water phase. The second year's data indicated some anomalous results, but thorough sampling of potential routes of contamination failed to reveal any other source than the monitored flow through White Oak Dam. Sampling was discontinued until a sampling program, designed to proportionally sample the flow releases from Melton Hill Dam, is installed. Core samples from the Clinch River system were taken to obtain the radioactive material profile in the river and to determine the radioactive inventory in the bottom sediments. Specially designed counting equipment was installed to automatically count the core in preset increments for gross gamma and to gamma-scan specific portions of the core. Correlation analyses of the radionuclides in the bottom sediments indicated that Cs^{137}, Ru^{106}, TRE, and Co^{60} are apparently deposited by similar mechanisms and that Zr^{95}–Nb^{95} and Sr^{90} are deposited by different mechanisms. It may be possible to predict movement of the group of nuclides by counting just one. Melton Hill Dam, a peaking power plant, will affect the hydraulic regime in the Clinch River by the sudden changes in discharge. Flume tests indicated that the effect of these changes will not cause greater dispersion than that observed with steady flow. A preliminary safety analysis of the discharge of radionuclides to the Clinch River was made. Dosages were compiled for the bone, gastrointestinal tract, thyroid, gonads, and total body for people at Clinch River Miles 14.5 and 2.6 and Tennessee River Miles 529.9 and 465.5, the critical points on the river system. For drinking water the largest fraction of $(MPC)_w$ attained was 0.51 in 1954. Variations in intake for sex and age differences indicated that dosages different than those obtained by standard man are possible. Immersion in contaminated water resulted in a maximum dose of 0.027 millirad/day in 1960. The greatest dose from bottom sediments was 12 millirads per day of exposure in 1959. Other potential sources of exposure being investigated are those due to ingestion of irrigated crops and contaminated fish. (auth)

39300 (ORNL-3492(p.51-62)) STUDY OF WHITE OAK CREEK DRAINAGE BASIN. T. F. Lomenick, H. J. Wyrick, W. M. McMaster, R. M. Richardson, and D. A. Gardiner (Oak Ridge National Lab., Tenn.).

Analyses of a series of 250 core samples taken in the bed of former White Oak Lake showed that, as of December 1962, the soil contained 1038 curies of Ru^{106}, 704 curies of Cs^{137}, 152 curies of Co^{60}, 17 curies of the rare earths

(exclusive of Y^{90}), and 15 curies of Sr^{90}. Approximately 65% of the activity was found in the upper 6 in. of soil. Studies on the movement of radionuclides in White Oak Creek indicated that: the amount of activity transported downstream by suspended solids is small during low creek flow rates and/or low suspended-solids loads, but during high stream flow and/or high suspended-solids loads, significant quantities of strontium and practically all the cesium are associated with sediments; suspended solids of less than 9 μ absorb considerably more activity than larger particles; and the amount of cesium associated with suspended solids increases considerably with a rise in the creek, and the amount of strontium associated with the liquid phase shows a pronounced increase. Mean velocities in White Oak Creek of 0.4 to 2.3 fps at discharges ranging from 4.5 to 200 cfs were determined from time-of-travel studies. Water levels were measured in the permanent wells in White Oak Creek Basin in March (the time of highest ground-water surface) and showed greater annual variations at the higher elevations above the valley floor than at the lower elevations. (auth)

39301 (ORNL-3492(p.62-70)) MINERAL EXCHANGE STUDIES. Tsuneo Tamura, W. P. Bonner, F. S. Brinkley, D. G. Jacobs, O. H. Myers, and Tohru Murano (Oak Ridge National Lab., Tenn.).

Heat-treated gibbsite is highly selective for strontium in alkaline systems. The capacity of heat-treated gibbsite is approximately 4 meq/100 g for cesium and 12 meq/100 g for strontium. The affinity for strontium of the heat-treated material is reflected by the lessened ability of sodium ions to desorb the strontium. After the sorbent was leached with sodium equal to 23 meq of Na^+ per meq of sorbed Cs^+, 96% of the cesium was desorbed; but when strontium was sorbed, only 77% of the strontium was desorbed after leaching with sodium equal to 730 times the amount of strontium on the sorbent. Several other hydrous oxide minerals were heated to 500°C in order to determine whether this heat treatment could improve their properties for sorbing strontium. Goethite ($HFeO_2$), diaspore ($HAlO_2$), and limonite ($Fe_2O_3 \cdot xH_2O$) were used; heat-treated limonite showed the best strontium-sorbing characteristics. Strontium removals by four different sorbents were compared using column techniques. Tests were performed using a 0.5$\underline{M}$ $NaNO_3$ solution adjusted to pH 10 and containing $10^{-5}\underline{M}$ $Sr(NO_3)_2$; the flow rate was 3 ml min^{-1} cm^{-2}. Commercial-grade activated alumina was most efficient; the 50% breakthrough volume for 10 g of material was approximately 6500 cm^3; the same weight of Dowex 50-X12 treated 2600 cm^3 for the same breakthrough percentage. Sorption of trace quantities of cesium by vermiculite can be improved by pretreatment with potassium to increase the number of collapsed lattices available for edge fixation. Continued leaching of the treated vermiculite with 0.5$\underline{M}$ $NaNO_3$, containing traces of cesium ($1.7 \times 10^{-7}\underline{M}$), releases the interlayer potassium and negates the pretreatment. Addition of potassium in the influent was found effective in maintaining potassium-treated vermiculite in a collapsed state. A concentration of 0.0005$\underline{M}$ KNO_3 in 0.5$\underline{M}$ $NaNO_3$ gave optimum cesium sorption (K_d = 366 ml/g) and a final exchange capacity of 46.8 meq/100 g compared to the initial exchange capacity of the potassium-saturated vermiculite of 5.9 meq/100 g. Interlayer fixation of trace quantities of strontium was not observed when the vermiculite lattice was collapsed by addition of 0.01 to 0.04$\underline{M}$ KNO_3 to 0.5$\underline{M}$ $NaNO_3$ influent. The sorption of strontium was reduced by increases in the potassium concentration of the influent, and approximately 80% of the strontium was removed during the determination of the exchange capacity following column saturation. (auth)

39302 (ORNL-3492(p.70-6)) ENGINEERING, ECONOMIC, AND SAFETY EVALUATIONS. R. L. Bradshaw, J. J. Perona, L. C. Emerson, and J. O. Blomeke (Oak Ridge National Lab., Tenn.).

Studies of interim storage of calcined wastes and the effects of fission product removal on waste-management costs were completed. Interim storage facilities were designed to handle calcined waste cylinders for assumed storage periods of 1, 3, 10, and 30 yr. The computed costs of storage of Purex and Thorex wastes together in the same facility ranged from 0.0015 mill/kwhr(e) for 1 yr storage to 0.0048 mill/kwhr(e) for 30 yr storage for the calcined acid wastes, and from 0.0018 to 0.0063 mill/kwhr(e) for the calcined reacidified wastes. The object of the fission-product-removal study was to compare the waste-management costs for wastes with 90 and 99% of the fission products removed with the costs for managing the original waste with all fission products present. In each case, costs were estimated for the interim storage of liquid waste, pot calcination of waste, shipment of the calcined solids, and disposal of the solids in a salt mine. Total waste-management costs for the waste depleted of 99% of the fission products were only about 7% lower than for the 90%-depleted wastes, and both fell in the range of 0.017 to 0.019 mill/kwhr(e). Management costs for the original waste [0.024 mill/kwhr(e)] were only about one-third higher. The tank storage hazard study has resumed under a modified set of basic postulates. Possible exposures of large populations to radiation resulting from accidental large-scale activity releases are being considered theoretically. (auth)

39303 (ORNL-3492(p.76-8)) RELATED COOPERATIVE PROJECTS. (Oak Ridge National Lab., Tenn.).

The U.S. Geological Survey continued to obtain partial-record base-flow, and crest-stage records for the area. In addition, a geologic map of White Oak Creek Basin, with an explanatory text, was prepared. Courses and lectures were given. (auth)

39304 (ORNL-3492(p.81-95)) RADIOACTIVE WASTE AREA AND RADIATION EFFECTS STUDIES. S. I. Auerbach, D. A. Crossley, Jr., P. B. Dunaway, et al. (Oak Ridge National Lab., Tenn.).

In dosimetry studies, miniature metaphosphate glass rods are being used to estimate absorbed dose in air and in the plants and soils of White Oak Lake bed. Combined beta and gamma doses in the top inch of mineral soil ranged from 20 to 25 rads/day on the northwest edge of the lake bed where Ru^{106} seepage from higher ground is appreciable. Absorbed doses in air at the surface of marsh plants (Typha latifolia L.) in this area ranged vertically from 6.2 rads/day at ground level to 2.8 rads/day at 5 ft above the ground. Absorbed doses in stem tissue of these plants were 23% higher due to absorbed radionuclides, principally Ru^{106}. The dose to root systems was three to seven times higher than the dose to shoot components. In food-chain studies of cotton rats maintained in pens on White Oak Lake bed and feeding on native vegetation, it was found that the concentrations of radionuclides in tissues are positively correlated with the corresponding concentrations in stomach contents and plants, the concentrations of radionuclides in tissues are not correlated with corresponding concentrations in soil, Sr^{90} in femurs is the only radionuclide in the tissues which was in greater concentration than in food or plants, and the placental and mammary barriers apparently were effective in reducing the

concentration of Sr^{90} in fetuses and nursing young. Blood samples were taken from the original cotton rats one week before release into pens and at 4- to 6-week intervals thereafter. Blood analyses were also made on samples from rats born in the pens. Analyses of erythrocyte and leucocyte counts, leucocyte differential counts, hematocrits, mean corpuscular volumes, cell-volume distributions, and total serum solids were performed. These analyses showed no apparent effects of ionizing radiation in the blood of cotton rats maintained in the pens for this experiment. Studies on hematology of native mammals continued to support the previous discovery that the number of erythrocytes is inversely related to species size and that the mean erythrocyte volume is directly related to the species size. This relation was found to be present in the rodent families Muridae and Sciuridae, the shrew family Soricidae, and the primate family Cebidae. Seasonal effects on the blood of native mammals are being followed because of variations noted in cell counts and hematocrits of the blood of mammals trapped during various seasons of last year. Erythrocyte counts and hematocrits, for instance, in some species seemed to be higher in the winter than during other seasons. Use of trees as long-term monitors of radioactive seepage from underground waste pits was tested by sampling even-age pines growing around waste pit No. 5. Significant concentrations of four gamma-emitting radionuclides were found in these pine trees. These nuclides were Ru^{106}, $Zr^{95}-Nb^{95}$, Cs^{137}, and Ce^{144}. Concentration of Ce^{144} was between 100 and 200 $\mu\mu$c per g of dry weight, which is the same as fallout levels. Cs^{137} concentration was uniform in all trees at 30 to 70 $\mu\mu$c per g of dry weight. This amount could be attributed to blowout from three open pits which are due west of waste pit No. 5. Ru^{106} concentration varied from 0.02 μc per g of dry weight to fallout levels, which are 40 to 70 $\mu\mu$c per g of dry weight. Twenty-three of the 73 trees collected showed a concentration of Ru^{106} greater than that which could be attributed to fallout or to blowout from the open pits. This higher concentration is attributed to seepage (and subsequent uptake by the tree) from waste pit No. 5. Five trees showed a concentration of $Zr^{95}-Nb^{95}$ which was greater than fallout levels and also greater than Ru^{106} levels. The highest concentration of $Zr^{95}-Nb^{95}$ was 771 $\mu\mu$c per g of dry weight. Concentration of all the isotopes except $Zr^{95}-Nb^{95}$ tended to be greater in needle material than in twig material. Fission foil threshold detectors were used to determine the fast-neutron dose absorbed by white oak acorns irradiated in the ORNL Graphite Reactor. The acorns were irradiated in a 17 × 8 × 4.5 in. box of boron–carbide–impregnated Lucite, which absorbed thermal neutrons (over 50% of the total flux) but allowed fast neutrons to pass through the seed. Fission foils and pellets of S^{32} were placed under and on top of the sample to be irradiated, seed stacked to a depth of 4 in. After irradiation the foils and sulfur were counted immediately in the special fission foil counters of the Health Physics Division. Dose calculations were made according to the method of Hurst and Ritchie. The dose under 4 in. of acorns was 1755.8 rads/hr, whereas the dose over 4 in. was approximately 1250 rads/hr. Use of biological elimination of radioisotopes in insects as indirect measures of metabolism under field conditions was continued with emphasis on the influence of temperature on elimination rates. In geometrid caterpillars the biological half life of Cs^{137} was decreased by one-half for a 10° rise in temperature. Similar temperature-related trends were found for leaf beetles (Chrysomela knabi) and millipedes (Dixidesmus erasus). (auth)

39305 (ORNL-3492(p.95-107)) FOREST STUDIES. J. S. Olson, G. N. Brown, D. A. Crossley, Jr., et al. (Oak Ridge National Lab., Tenn.).

Computer feedback models have included compartments for woody materials, as a step toward interpreting patterns of forest growth. The positive feedback representing increased photosynthetic rate with increased foliage mass is counteracted by opposing negative feedbacks, representing not only the loss rates from respiration and other processes (litter fall, consumption, translocation) but also a "limiting feedback" related to the capabilities of an area for producing organic matter. Diurnal and seasonal cycles of production were combined in the same model. Further analyses of two- and three-year comparative experiments, in cooperation with the Botany Department of the University of Tennessee, showed different rates of breakdown for several kinds of deciduous leaves measured in the Oak Ridge Reservation and the Great Smoky Mountains. In all environments, leaf species showed large and consistent differences in weight loss of leaves confined in bags of nylon net. Mulberry decayed rapidly to black humus, losing 0.002 to 0.0046 of its total weight per day in different environments. Beech showed the slowest visible signs of decay, with fractional weight losses of only 0.0003 to 0.0012 per day. White oak, Shumard red oak, and sugar maple showed intermediate rates of weight loss and visible destruction. Yearly differences in decay rates emphasize the need for several-year experiments, using closely compared sets of techniques, for drawing generalizations about rates of ecological processes which affect the movement of nutrients or isotopes in contrasting environments. Seasonal measurements of microbial populations of four leaf species in three contrasting forest types during the first year showed a highly significant correlation between leaf weight loss and microbial respiration, especially that of bacteria. Seasonal fluctuations of microbial respiration were primarily correlated with temperature, but other significant correlations were found with bacterial counts, moisture content of the leaves, and age of the litter. The large-scale tracer experiment employing Cs^{137} in a small stand of yellow poplar is confirming the expectation of rapid circulation of Cs^{137} through the forest ecosystem. The rapid attainment of maximum foliage concentrations in June was followed by a decrease throughout the growing season. Evidence was found of a marked withdrawal of Cs^{137} from the leaves back into the trunk prior to leaf fall. Rainwater collections further supported the possibility that in late summer there is a period in which alkali metal reserves are remobilized into the tree. Paper chromatography analyses, autoradiograms, and column elution tests showed that the bulk of Cs^{137} activity is in the phloem tissue (parenchyma), where it exists only in the ionic form, and that only ionic bonding takes place between the cesium and the wood. In addition to Cs^{137} income from rainfall and litter fall, downward movement of Cs^{137} in roots of tulip poplar apparently provides an important contribution of this nuclide into the soil (Emory silt loam) of the tagged forest. Early litter sampling on lines on a close spacing (2 cm) showed very abrupt variation, due partly to uneven movement of rainout over the incomplete litter cover of the mull humus. The extent of variation within centimeter distances was greater than two orders of magnitude. Early sampling indicated the importance of root contribution to the highly variable initial distribution. Root fragments which could be separated from inorganic soil particles contributed at least 90% of the total activity as of July 16, 1962. Fine rootlets that could not be separated from sieved mineral soil may already have

contributed to radioactivity in this and subsequent samples. Wide differences in concentrations of Cs^{137} were found in mushrooms growing on the tagged forest floor. This variability was not only the result of large differences among substrates but also the result of differences within one substrate at different locations. Concentrations of Cs^{137} in litter were from 0.1 to 68 times lower than the concentrations in the underlying soil and roots. Variations in concentrations of Cs^{137} in mineral soil exceeded two orders of magnitude for surface samples taken only 10 cm apart. Two types of food chains are being compared in the tagged forest: the green foliage–herbivorous arthropod–predaceous arthropod type of food chain and the leaf litter–herbivorous arthropod–predaceous arthropod type. Cs^{137} concentrations were lower in the leaf litter–soil arthropod food chain than in the green foliage food chain, since leaching of cesium from green leaves was the radioisotope source for the litter layers. Radioisotope concentration in leaf litter increased gradually during the summer and abruptly during the early autumn as leaf fall progressed. During the summer months herbivores had Cs^{137} concentrations almost as high as the concentration in leaf litter. Herbivore radioactivity increased in the autumn but not as rapidly as did leaf litter radioactivity. Predators also showed an increase in Cs^{137} content during the summer and early autumn. During July and August the herbivore and predator parts of the leaf litter–soil arthropod food chain had an added input due to direct feeding on the green foliage. Phalangids (Liobunum sp.), for example, had Cs^{137} contents which were a factor of 2 or more higher than leaf litter concentrations. Also, some of the predators were evidently feeding in the green foliage food chain although they were trapped on the forest floor. The result was that the animal portions of the leaf litter food chain appeared abnormally high during July and August. In October the green foliage had disappeared, and the leaf litter food chain assumed a Cs^{137} distribution resembling that of the green foliage food chain. (auth)

39306 (ORNL-3492(p.107-15)) CLINCH RIVER AND RELATED AQUATIC STUDIES. D. J. Nelson, S. I. Auerbach, N. R. Kevern, B. G. Blaylock, R. E. Martin, G. M. Rosenthal, R. C. Early, and N. A. Griffith (Oak Ridge National Lab., Tenn.).

Aquatic studies continue to emphasize the fate and effects of radionuclides released to the Clinch River via White Oak Creek. Analyses of stable strontium in the flesh and bone of white crappie were continued to test the relation of the distribution of stable strontium and Sr^{90} between the environment and the fish. If the distribution of stable strontium and Sr^{90} between fish tissue and water is the same, it should be possible to predict Sr^{90} concentrations in tissue for continuous environmental releases. Samples were taken at monthly intervals to determine whether there are seasonal changes in the strontium concentrations in fish tissue. The average stable-strontium concentration in bone was 271 ± 6.34 ppm (± one standard error) based on 105 samples. This quantity of strontium in bone is a concentration factor of 4.0×10^3 over that in Clinch River water. Strontium concentrations in flesh average 0.0813 ± 0.0118 ppm (27 samples), which is a concentration factor of 1.2 over that of river water. The biological half life of strontium in white crappie was determined by tagging fish with Sr^{85} and then counting the same fish at 1-min intervals in a small-animal whole-body counter. In experiments completed, the biological half life of strontium in the flesh of different individuals has ranged from 12 to 48 min, somewhat shorter than anticipated previously. The transport of Sr^{90} from the Clinch River by emerging aquatic midges (Chironomidae) was compared with the accrual of Sr^{90} to the river from weapons-testing fallout. Larval development of the midges occurs in the contaminated river-bottom sediments. Emerging adults were caught in insect light traps operated on the river bank at dusk. Adults in one large, composite sample contained 8.76 times as much Sr^{90} [$(3.55 \pm 1.13) \times 10^{-6}$ μc per gram of dry weight] as did an equal quantity of river-bottom sediment from the same location. Studies elsewhere have shown that 10 g m^{-2} yr^{-1} may be contained in the emergent insect biomass. These emergent insects would transport $(3.55 \pm 1.13) \times 10^{-5}$ μc of Sr^{90} per square meter per year from the river bottom. The average increment of Sr^{90} from fallout in the United States between 1959 and 1960 was 4.2×10^{-3} curie/square mile (1.62×10^{-3} μc/m^2). Thus, fallout entering the river directly would add 45 times as much Sr^{90} as removed by emerging chironomids. Studies of the relative influence of stable strontium and stable calcium on strontium are in progress using the snail Physa heterostropha and highly purified and assayed calcium carbonate. Preliminary results suggest that strontium uptake is dependent primarily on stable strontium in the environment. A study of the age distribution, growth rates, and dispersion of smallmouth buffalo, Ictiobus bubalus (Rafinesque), in Watts Bar Reservoir, and of their importance as an accumulator of radionuclides, was completed. The ages of 1271 commercially caught fish ranged from 4 to 15 yr; the largest number were from year class 6, the youngest year class which was completely vulnerable to commercial fishing gear. Total survival rates were found to be 49% for year class 6, 35% for year class 7, 26% for year class 8, and 19% for year class 9. A high concentration of radionuclides in the environment was found to be necessary for smallmouth buffalo to accumulate measurable quantities in their scales. White Oak Creek is the only area of Watts Bar with sufficient radionuclide contamination for such accumulation to occur. If surface area is considered a measure of available fish habitat, White Oak Creek comprises less than 0.02% of Watts Bar Reservoir at full pool. Only a small percentage of the population would be expected to be resident in the contaminated area. However, with mobile populations contamination could be expected in larger numbers of fish because of movement into and out of White Oak Creek. This contamination could be detected in tissues such as bone or scales having a long biological half-life for the several radionuclides released. Radiometric surveys of scales revealed the smallmouth buffalo population of Watts Bar Reservoir to be a relatively minor accumulator of radionuclides, with only 0.08% having a detectable accumulation in their scales. Approximately 6% of the Clinch River fish and 77% of the White Oak Creek fish had measurable radionuclide accumulations. The salivary gland chromosomes of Chironomus tentans larvae collected from White Oak Creek and from six uncontaminated areas were examined for chromosomal aberrations. White Oak Creek populations were exposed to a dose rate calculated as 230 rads/yr, or about 1000 times background. Fifteen different chromosomal aberrations were found in 365 larvae taken from the irradiated population as compared with five different aberrations observed in 356 larvae from six control populations, but the mean number of aberrations per larva did not differ in any of the populations. The quantitative amount of heterozygosity was essentially the same in the irradiated and the control population, but there was three times the variety of chromosomal aberrations found in the irradiated area. From this evidence it was concluded that chronic low-level irradiation from radioactive waste was increasing the variability of

chromosomal aberrations without significantly increasing the frequency. (auth)

39307 (ORNL-3492(p.119-33)) THEORETICAL RADIATION PHYSICS. J. Neufeld, R. H. Ritchie, R. F. Adkinson, J. C. Ashley, F. J. Davis, R. N. Hamm, W. S. Snyder, J. E. Turner, R. Woodyard, and H. A. Wright (Oak Ridge National Lab., Tenn.).

Calculations of rad and rem doses in a tissue slab from protons with energies up to 400 Mev were completed. A code was also developed for calculating dose in a finite geometry phantom (parallelepiped), and results for this case are nearing completion. Preliminary studies at proton energies greater than 400 Mev are in progress. A code was written to compute the distribution of dose with LET, in order to analyze the biological response of animals exposed to neutron irradiation. An investigation of shell corrections in atomic stopping-power theory was made. The low-energy end of the slowing-down spectrum of electrons in a free-electron gas was computed using a numerical solution of the appropriate integral equation and numerical values of the requisite interaction cross sections. The dispersion relation for surface plasmons was investigated in a semiclassical approximation. An analytic solution for the distribution of transition radiation from a two-layered foil was obtained. A semiclassical derivation was given of the cross section for photon absorption in metals due to the presence of impurity scattering centers. A formulation of the constitutive equations for a moving medium was given. The interaction of an electron or an ion beam moving through a stationary plasma was investigated. (auth)

39308 (ORNL-3492(p.134-43)) EXPERIMENTAL PHYSICS OF DOSIMETRY. R. D. Birkhoff, E. T. Arakawa, T. E. Bortner, et al. (Oak Ridge National Lab., Tenn.).

Work on the interaction of alpha particles with water molecules revealed that the interaction is a physical process in which the cross section for momentum transfer is a factor of 2 larger than that obtained from theory. The cross section for the dissociative electron capture process in D_2O was measured and compared with that obtained in H_2O. The time-of-flight technique for investigation of electron transport in gases was applied to the measurement of drift velocities and diffusion coefficients in several gases and, in particular, in mixtures of water vapor and ethylene. A version of the electron time-of-flight machine is under construction and will permit measurements to be made for a wider range of gases. A combination of spectroscopic and ionization experiments on the effect of alpha particles on atomic argon led to a description of the ways in which alpha particles interact with atomic argon. The angular and spectral distribution of photons emitted by silver foils, 660 and 1980 Å thick, when bombarded by 40-kev electrons was determined experimentally in the wavelength region 2500 to 5600 Å. The spectral distribution of light polarized in the plane of incidence showed a sharp peak at 3300 ± 12 Å, this value being an average over photon directions 10 to 50° from the foil normal. In addition to the peak, the spectrum showed a continuum which decreased slowly with increasing wavelength and a deep minimum at 3200 Å with a rise in the shorter wavelengths. The angular distribution of photons emitted at the peak wavelength showed a maximum at 30° from the foil normal with zero intensity at 0 and near 90°, whereas the photons emitted at other wavelengths in the continuum, for example, at 2700 and 4500 Å, were most intense at 50° from the foil normal. An operational analyzer was designed and built for generalized dosimetry applications. The transmission, resolution, and energy calibration of the Keplertron, a spherical electrostatic analyzer, were further checked with the Sm^{152} Auger line at 32.8 kev and the Ni^{64} Auger line at 6 kev from relatively thin sources of Eu^{152} and Cu^{64}, respectively, and found to be in good agreement with the values previously determined at lower energies by means of an electron gun. The electron slowing-down spectrum in copper of negatrons from Cu^{64} was measured with the Keplertron and found to be in absolute agreement from 37 kev to 1 kev with the Spencer-Fano theory. Difficulties in experimental techniques used in making the measurement were either corrected or are under study. Programs were written for the CDC 1604 computer to calculate theoretical spectra and to correct experimental data. (auth)

39309 (ORNL-3492(p.143-5)) PHYSICS OF TISSUE DAMAGE. R. D. Birkhoff, J. G. Carter, D. R. Nelson, and D. A. LaBar (Oak Ridge National Lab., Tenn.).

The intensity of thermoluminescence was shown to depend strongly on the presence of a gas both during the irradiation of the sample and during the subsequent warmup. Experiments were conducted in an effort to understand the mechanisms involved in this gas effect. One experiment was an attempt to observe whether the ions or electrons formed in the gas during irradiation influenced the thermoluminescent intensity. This experiment gave negative results. An attempt was also made to detect by gas chromatography gaseous emissions from the samples, particularly as these might correlate with the optical emissions. Another experiment involved the technique of electron spin resonance. Correlations between the numbers of radiation-induced spins and integrated thermoluminescent intensity for varying sample crystallinities and gaseous conditions were sought. No gaseous dependence of spin resonance signals was found. An electron gun is under development which will permit studies of electronic energy levels excited in solids and gases by the passage of fast electrons. A time-of-flight energy selection will be used to obtain an electron beam homogeneous in energy to 0.01 ev, thus enabling studies of energy levels of this or higher energies. The gun, drift tube, and electronics were assembled, and bursts of electrons having energies between 2 and 15 ev were obtained. The square of the reciprocal arrival time was found to be a linear function of the electron energy as expected from elementary kinematics. A gun, ultrahigh vacuum system, and open-window electron multiplier are being installed. (auth)

39310 (ORNL-3492(p.146-54)) RADIATION DOSIMETRY. J. A. Auxier, M. D. Brown, J. S. Cheka, et al. (Oak Ridge National Lab., Tenn.).

Work was carried out on the Ichiban Dosimetry Program, dosimetry research, and installation of the Health Physics Research Reactor. Analysis of most of the data from Operation BREN was completed, and the HPRR commenced routine operation on May 31, 1963. A study was completed on the long-term buildup and fading in metaphosphate glass. (auth)

39311 (ORNL-3492(p.157-75)) ESTIMATION OF INTERNAL DOSE. (Oak Ridge National Lab., Tenn.).

The program of the Internal Dose Estimation Section is directed toward radioactive materials which enter the body. In particular the maximum concentrations are estimated for radioactive materials in air, $(MPC)_a$, or in water, $(MPC)_w$, that would limit the burden to a prescribed amount over a working life. A retention function was defined which represents the retention of strontium in the body over extended periods of adult life. The function consists of three exponential terms, two of which are obtained by simultaneously adjusting the parameters so that retention and excre-

tion data during the period of about 100 to 200 days following injection of strontium are represented. The third exponential is obtained by selecting parameters to make the function consistent with data on levels of stable strontium in diet and in bone of Western man and to be in fair agreement with data on the rate of remodeling of bone. Thus the function is in reasonably good agreement with the data now available on chronic retention of strontium in normal adults. Using this model, $(MPC)_w$ values for Sr^{90}, Sr^{89}, and Sr^{85} were obtained and compared with values derived on the basis of other models. On the basis of the general agreement of these models, it is suggested that an $(MPC)_w$ of 4×10^{-6} $\mu c/cm^3$ is acceptable for occupational exposure (168 hr/week) to Sr^{90}. (auth)

39312 (ORNL-3492(p.176-82)) STABLE-ELEMENT METABOLISM BY MAN. (Oak Ridge National Lab., Tenn.).

The elemental composition of bodies of grossly normal adults provides one of the best sources of information concerning the distributions of various isotopes within the body that are to be expected following chronic exposure to the materials. In the search to determine the elemental composition of standard man, 415 bone samples were analyzed from long-term residents of 11 major cities in the United States and 13 cities in foreign countries. Each sample was examined for 20 elements. These data are an extensive source of information on the concentrations of many trace elements in bone. The accuracy of the Quantometer values was checked for several elements using atomic absorption, flame spectrophotometry, and colorimetry. In each case the agreement was generally good. The influence of age, race, and geographical location on the trace-element content in tissue was studied. On the whole the concentrations of trace elements were not different from those in adults, but certain elements showed significant variations. Except for the higher lead ($p \leq 0.05$) in kidney, liver, and lungs of males, there were no sex differences in the American group. There appeared to be no significant differences due to race per se. (auth)

39313 (ORNL-3492(p.185-93)) AEROSOL PHYSICS. B. R. Fish, G. W. Royster, Jr., J. L. Thompson, F. G. Karioris, Liliana Masironi, R. S. Sager, P. Kotrappa, A. J. Moll, J. E. Swander, and R. L. Walker (Oak Ridge National Lab., Tenn.).

Fundamental and engineering studies of radioactive surface contamination are continuing. Major emphasis is on the development of reproducible sampling techniques for evaluating the extent of particulate contamination on surfaces and the application of redispersion test results to the establishment of contamination control criteria. Studies of contamination sampling indicated that the smear and adhesive paper methods are strongly affected by the characteristics of the surface, the concentration of the contaminant, and variations in technique among monitoring personnel. A sampling method, employing air dispersion, is essentially independent of surface roughness and dustiness, and results in minimal monitoring variation among different personnel; redispersion efficiency varies with particle size of the contaminant and with velocity of the air impinging on the surface. The adsorption of radioactive iodine vapor onto condensation nuclei was investigated by use of aerosols produced by exploding silver and platinum wires. In the absence of aerosol particulates, the iodine vapor diffuses to the container walls with a half life of 49 min. When the metallic aerosols are mixed with the iodine vapor, iodine concentration in the container is lost at a much slower rate. In the case of platinum aerosol, 17% of the iodine is associated with a particulate phase which is lost to the container walls with a half life of 6.9 hr; the remainder is lost with a half life of 41 min. The silver aerosol adsorbs and retains the iodine much more effectively than does the platinum aerosol. The high-volume annular impactor is an air sampling device which employs inertial forces to deposit airborne particulates on a collecting surface. Dust deposition patterns usually include a central circular deposit and one or more annuli of deposited dust with definite minima or clear areas separating the deposition sites. Study of the design and operating parameters of the device showed that deposition of dust at the center and at the primary impaction annulus begins as soon as the sampler is started; all parts of the pattern develop concurrently. Investigation of the airflow patterns near the collecting surface indicated the presence of at least two stable, toroidal vortices contiguous to the surface. To a considerable degree, the patterns of static pressure distribution and dust deposition appeared to be correlated. Tests were continued to explore the capabilities of the exploding wire aerosol generator to produce and disperse a wide variety of submicron aerosols. Aerosols can be produced which differ greatly in chemical composition, density, electrical and thermal conductivity, permittivity, and other physical properties which may be of interest in testing instruments or simulating health physics field problems in the laboratory. Wires or foils of 18 different metals were exploded in a nitrogen atmosphere. The pertinent data regarding yield and composition of the resultant aerosols are tabulated. It was found that aerosol yield increases with increasing gas pressure in the explosion chamber at all operating voltages, but the primary particle size is not affected dramatically by either pressure or voltage. These and other findings of the study may indicate that particle formation in the exploding wire phenomenon occurs in the shock wave. (auth)

39314 (ORNL-3492(p.194-206)) APPLIED INTERNAL DOSIMETRY. (Oak Ridge National Lab., Tenn.).

Continuing improvements of instrumentation and operating program at the ORNL In Vivo Gamma-Ray Spectrometry Facility (IVGS) made it possible to increase the rate of routine in vivo counts for monitoring purposes and, at the same time, initiate a limited research program. A thin-crystal assembly [three NaI(Tl) crystals 5 in. in dia by $^1/_{16}$ in. thick] is now available for use in the spectral analysis of electromagnetic radiation in the energy region below 150 kev. Thin crystals are particularly important in the study of lung burdens of plutonium. At present, the assembly can detect slightly less than 40 nanocuries of Pu^{238} in the chest region, provided a background count is made on the individual prior to the plutonium exposure (four standard deviations). If no such prior count is available, the limit of detection is increased to slightly less than 80 nanocuries of Pu^{238} in the lungs. The routine monitoring program, previously confined to examination of known or suspected exposure cases, was expanded in scope. Increased emphasis is being placed on counting of potentially exposed persons and obtaining baseline counts for individuals prior to their entering new work involving potential internal radiation exposure. All routine human counts are made in a scanning bed geometry in which the subject, lying prone on a rolling bed, is moved under an 8- by 4-in. NaI(Tl) crystal. This counting mode replaces the chair geometry formerly used for most routine counting. Gamma detection efficiency for scan counts is approximately equal to chair count efficiency and may be less sensitive to changes in geometry occasioned by nonuniform distribution of radioisotopes in the subject being counted. The computer program for processing in vivo counting data can now be used

in evaluating a majority of the routine counts. As a result, less analyzer time is required for obtaining and evaluating net spectra. During the past year a total of 492 human counts was made. The present rate of counting is about 110 persons per month, excluding instrumentation downtime. A study was made of the uptake and retention of I^{131} by human thyroid gland. The work was undertaken to provide human data with which to evaluate the ICRP-NCRP parameters, assumptions, and predictions regarding the uptake and retention of radioiodine. Five male volunteers ingested cow's milk containing I^{131} bound to the milk protein. Uptake of I^{131} by the thyroid was measured by gamma counting at the IVGS facility. A 3- by 3-in. lead-collimated NaI(Tl) crystal was positioned over the thyroid gland of the supine subject, in contact with his throat. Three of the subjects also submitted total voiding urine during the study. The amounts of I^{131} ingested were small in comparison with permissible levels but provided adequate counting rates. Two cases of single ingestion and three cases of repeated daily ingestion were compared. Best-fitting curve plots of the data were obtained by the least-squares method using two different weighting factors. The data, presented in tables and graphs, show that extrapolations from single intake data and the application of ICRP-NCRP parameters provided slight overestimates of the thyroid and whole-body burdens observed in the cases of chronic intake. Data from the two single ingestion cases were helpful in evaluating a case of accidental inhalation of I^{131} vapor. The ingestion and inhalation cases are compared. Phosphoric acid, obtained through normal laboratory supply sources, was found to contain minute quantities of radium D (Pb^{210}) and its daughters. When 10 ml of H_3PO_4 was added to urine in the $BiPO_4$ precipitation procedure for determining plutonium in urine, the alpha count background was increased by 0.4 dis/min. This was probably due to the alpha of Po^{210}, one of the radium D daughters. Quantitative removal of these contaminants from the H_3PO_4 by means of cation exchange resin treatment can reduce the reagent contamination of the urine specimen analysis from about 0.4 dis/min to 0.08 dis/min per sample. Analysis of cattle thyroids and of milk for fallout I^{131} continued. Data from the period of highest I^{131} activity indicate that the concentration of radioiodine in a liter of milk averages only about 8% of the concentration per gram of cattle thyroid. Milk must be reduced in volume by a factor of about 8000 to 1 to achieve a detection sensitivity equal to the sensitivity for thyroids; while the thyroids require no laboratory preparation other than interim refrigeration. Cattle thyroids, therefore, are a valuable biological monitor of fallout I^{131}; they provide a sensitive detection limit with a minimum of laboratory equipment and preparation. (auth)

39315 (ORNL-TM-677) HAZARDS EVALUATION FOR BNL KILOROD PROGRAM. E. C. Moncrief, J. L. Matherne, M. G. Baillie, C. C. Haws, and J. D. Sease (Oak Ridge National Lab., Tenn.). Sept. 6, 1963. Contract [W-7405-eng-26]. 78p.

An evaluation was made of the hazards associated with the preparation of $ThO_2-U^{233}O_2$ fuel rods in the Kilorod Program. Building containment, ventilation, and waste systems are described as well as a radiation detection and monitoring program. Emergency procedures for the building are discussed. The maximum credible accident during the program was determined to be a nuclear excursion from 10 kg of U-233 in a primary containment cell. Present building shielding and containment would limit the maximum integrated dose (2-min exposure) to operating personnel in the event of an excursion to less than 450 mrem from gaseous fission products and prompt neutrons and gamma photons. The maximum downwind exposure from stack release of gaseous fission products would be less than 250 mrem. (auth)

39316 (RCC-R-165) AN ISOTOPE HANDLING CALCULATOR (MK.III) FOR GAMMA-RAY SOURCES WITH LEAD SHIELDING. R. West (United Kingdom Atomic Energy Authority. Research Group. Radiochemical Centre, Amersham, Bucks, England). July 1963. 4p.

Supersedes Reports AERE-I/R-1063 and AERE-I/R-1063(Rev.).

A circular slide-rule calculator is described which at a single setting inter-relates in direct terms the source strength, source distance, γ dose rate, and lead shielding requirements for the isotopes Na^{24}, Co^{60}, radium, Cs^{137}, Ir^{192}, I^{131}, and Au^{198}. (auth)

39317 (TID-19436) URINARY LEAD 210 AS INDEX OF MINE RADON EXPOSURE. Robert F. Bell and James G. Gilliland (Colorado. Univ., Denver. School of Medicine). [1962]. Contract AT(11-1)-637. 18p.

Inhalation exposure to Rn and its daughters was found to result in a body retention of Pb^{210}, physical half life of 22.2 yr. Ethylenediaminetetraacetic acid (EDTA) was found to enhance urinary excretion of Pb^{210}. The body burden of Pb^{210} in underground U miners was determined from the Pb^{210} content of urine after the administration of EDTA. The body retention pattern of trace amounts of Pb^{210} was studied in dogs with and without $CaNa_2EDTA$ or DTPA treatment and in mice. The excretion of Pb^{210} was found to average about 1.8% on the first day, 9.2% for the first yr, and was estimated at about 11.9% in 10 yr and 12.7% in 20 yr. Calculated retention of tracer Pb^{210} indicated that there would be a body build-up with repeated doses. (C.H.)

39318 (USNRDL-TR-656) RECOVERY OF PETROLEUM REFINERIES CONTAMINATED BY FALLOUT. L. Minvielle and W. Van Horn (Naval Radiological Defense Lab., San Francisco). June 24, 1963. 156p.

The Office of Civil Defense, Department of Defense, is sponsoring a series of studies on the recovery of certain essential major industries in the U. S. from the effects of nuclear attack. Various agencies are developing recovery input data that will eventually be fed to automatic computers to prepare production programs, consistent with surviving resources, for meeting priority requirements during the first two years after attack. The present study deals with the petroleum refinery industry. The case studied is that in which a given refinery is contaminated by radioactive fallout from one or more nuclear detonations occurring essentially simultaneously at some distance so that the refinery is not damaged by blast or fire. Before recovery of the plant can be started, entry into the plant area must be postponed until the radioactivity has decayed sufficiently so that excessive radiological doses will not be accumulated by recovery personnel. After entry, personnel must first decontaminate the vital areas of the plant, and then repair the equipment that has been damaged because of insufficient shutdown time. Estimates of the times and efforts required for recovery are made for a subgroup of 16 refineries that encompass all refinery sizes found in the industry; standard intensity ranges of radioactive fallout from 300 to 30,000 r/hr are considered. Generalized empirical formulations of these estimates are developed for the subgroup and are applicable to all refineries in the industry. Estimates of the times for recovery can be calculated for various choices of the controlling parameters, such as length of work shift, standard intensity, and size of

refinery. Recommendations are made that would reduce the effects of such attacks on oil refineries and expedite their recovery. (auth)

39319 A DEVICE FOR AUTOMATIC GENETIC PROTECTION IN CHEST RADIOGRAPHY ("GENOPROT"). Z. Hrabovszky and L. Huszar. Acta Chir. Acad. Sci. Hung., 2: 479-88(1961). (In English)

Preliminary to development of gonadal shielding measures, gonadal dosimetry studies were made in men and women, by use of ionization chambers, during diagnostic radiography and fluoroscopy procedures. According to these measurements, men receive exposures of 0.6 mrem and women 1.8 mrems during chest fluoroscopy. Fluoroscopy on children results in higher exposures as a consequence of the smaller dimensions of their body. Boys' gonads up to the age of one yr receive an exposure of 20 mrem, from 1 to 6 yr 0.8 mrem, and from 6 to 14 yr 0.5 mrem during a single chest fluoroscopy. Babies' gonadal exposure is thus 25-fold that of children of the ensuing age group and up to 40-fold that from 6 to 14 yr. In Hungary the frequency of chest fluoroscopy is very high, as a consequence of general social insurance. In postero-anterior chest roentgenographs taken with a depth diaphram an average of 0.34 and 0.28 mrem was the dose in 5-yr-old boys and girls, respectively, and in anteroposterior films of boys up to age 1 yr 16 mrem and in lateral films 38 mrem without depth diaphragm and lead shielding. With precise collimation and lead shielding the values were below 1 mrem. Automatic gonad protection was instituted through the Genoprot cassette stand for chest examinations. When the cassette has been adjusted to the patient's height and the horizontal central beam of x rays centered on the cassette, a protective shield will cover automatically, without separate adjustment, all body parts below to the useful lower limit of the thorax field being radiographed. To ensure a rapid, safe adjustment, a horizontal red-light film indicator on the cassette holder of the Genoprot shows the position for changing the film size and selecting another cassette size; by turning the selector switch mounted to the cassette holder the necessary correction is accomplished to ensure protection below the lower film margin. Scattered radiation is diminished in the patient by the back shield employed in the Genoprot, which also provides a sharper image on the radiograph. (BBB)

39320 DEVELOPMENT OF THE SWEDISH ROENTGEN STANDARD LABORATORY EQUIPMENT. R. Thoraeus (King Gustav V Jubilee Clinic, Stockholm). Acta Radiol. (N.S.), 1: 205-16(June 1963). (In English)

Improvements of the Swedish roentgen standard laboratory equipment, introduced in connection with an increase of its calibration capacity from 200 to 300 kv, are described. The employment of a sub-divided collector electrode, as well as the characteristics of the new 300 kv tube and the new diaphragm system, and precision measurements of diaphragms are discussed. (auth)

39321 RADIATION HAZARDS OF PRIMARY CONCERN TO PUBLIC HEALTH: PRESENT STATUS AND OUTLOOK Russell H. Morgan (Johns Hopkins School of Hygiene and Public Health, Baltimore). Am. J. Public Health, 53: 872-7(June 1963).

The radiation hazards currently of primary concern to public health are fallout of radioiodine from testing nuclear weapons and excessive x-ray exposures performed by careless and sometimes poorly trained physicians. Because of the relatively short half life of I^{131} (8 days), it might be expected to be of little consequence as a public health hazard following nuclear weapons testing. However, the yield of I^{131} from a nuclear weapon is sufficiently high that considerable contamination of the environment takes place, and the hazard to the general population becomes greatest when the weapon is detonated at low altitude. The ground contamination problem increases as the altitude of detonation decreases. After the USSR tests of 1961, levels of I^{131} contamination rose rapidly—in a few communities to a level which, if continued over a period of several months, would cause a dose in excess of the Federal Radiation Council's (FRC) radiation protection guide of 0.5 rem. The meteorologic aspect is of interest to public health authorities because it clearly indicates the manner in which variation in the weather pattern may cause fallout to occur from time to time in quite unexpected places. As a result of later detonations, estimates indicate that in some regions of the United States the radiation dose received by the thyroid glands of children may reach a level of 1.5 rem/yr, which represents the ingestion of 100,000 $\mu\mu$C of radioiodine. This amount is 3 times the quantity of radioiodine recommended by the FRC as a maximum limit. The FRC has announced that its radiation standards, applicable to the peacetime uses of radionuclides, do not apply to environmental contamination from fallout. The political implications of this decision, as well as the confusion it has introduced among public health authorities, are discussed. Reduction of the I^{131} hazard by the use of dried or stored fresh milk by infants and lactating mothers, and addition of stable iodide to the diet, are also discussed. Problems of medical overexposure to radiation are, in general, the result of the use of unsafe x-ray equipment or careless use of x-ray equipment. It is recommended that exposure dose values to such tissues as the reproductive organs be reduced to 15 mr/yr or about 15% of the exposure dose from natural background sources, as an objective for which public health workers should aim. (BBB)

39322 RADIATION CONTROL PROBLEMS FACED BY A LARGE CITY. Hanson Blatz and Daniel E. Lynch (Office of Radiation Control, New York City Dept. of Health). Am. J. Public Health, 53: 882-9(June 1963).

The duties and experiences encountered during the 4-yr operation of a radiation control agency are recounted. The most important part of a comprehensive radiation control program, in terms of overall exposure of the population, is the effort to minimize the radiation exposure from the medical and dental use of x-rays. The fact that much of the equipment is installed in apartment houses, other multiple dwelling structures, and office buildings means that a more critical evaluation of the structural shielding is necessary. An inspection of existing x-ray installations showed that much equipment had been installed in multiple dwellings without having the basic structural shielding considered standard practice for many years. Public health considerations relating to siting nuclear reactors in cities are discussed, particularly with respect to nuclear-powered vessels entering the harbors of large cities. The problem of safeguarding the public from hazards associated with the transportation of radioactive materials in a large city is also discussed. Dosimetry tests showed that many watches being sold with luminous dials exceeded permissible dose rates, and many jewelry and department stores have been restrained from selling such watches. Other tests showed that, under normal use, television equipment does not emit a sufficiently high dose rate of x-rays to constitute a health hazard. (BBB)

39323 STRONTIUM-90: A RADIATION HYGIENE PROBLEM. R. Keil (Universität, Rostock, Ger.). Arch. Hyg. Bakteriol., 147: 11-27(Apr. 1963). (In German)

The worldwide distribution of Sr^{90} originating from nuclear reactors and weapons tests is discussed with reference to the following topics: formation and properties of Sr^{90}; its sources and the characteristics of fallout; its past and current levels in air, land, and water; its accumulation in plants, animals, and man; and methods for its elimination from food and water and from the human body. Nuclear reactions leading to the production of and decomposition of the isotope are outlined, and the derivation and validity of maximum tolerable levels for man are discussed. Meteorologic factors involved in the worldwide distribution of tropospheric and stratospheric fallout are considered. Levels in various localities are compared with the fallout measurements made in Rostock between October, 1961, and October, 1962, the average value of which was 12×10^{-7} mC/cm^2. At this level, the deposition in water was estimated to be 6 mC Sr^{90}/km^2/yr, so that Sr^{90} would account for ~1% of the total activity of water. The average specific activity for air for the same period in Rostock was 2.5 pC/m^3, which is about the same level found at this time in Frankfurt am Main. Surface and ground water in Rostock reached a specific activity of 15×10^{-7} μC/ml (1500 pC/l), which is about $1/150$ the maximum allowable concentration of total radioactivity and $1/6$ that for Sr^{90} in drinking water. Tables are provided showing Sr^{90} content of foodstuffs in various countries and concentrations in human bone according to age. It is concluded that the present level of Sr^{90} in the human skeleton averages about 1 pC/g Ca, which accounts for only about 2% of the natural radiation reaching bone, and thus does not constitute a serious hazard. (BBB)

39324 RADIOACTIVE PHARMACEUTICALS. Henry N. Wagner, Jr. (Johns Hopkins Univ., Baltimore). Clin. Pharmacol. Therap., 4: 351-70(May-June 1963).

The use of labeled drugs in diagnostic procedures is discussed, particularly with respect to radiation safety and detection, and specific applications to clinical problems as well as illustrative examples are provided. One way to minimize the radiation hazard to the patient is by use of instruments sensitive enough to yield statistically significant data without administering unnecessarily large doses of radiopharmaceuticals. Radiation to the patient can be limited by minimizing the effective time of exposure by choosing radionuclides with a rapid rate of physical decay, and by using rapidly excreted materials. Another important principle in reducing radiation dosage is the use of radioisotopes that have low-energy radiations or, whenever possible, no β radiations at all. Such radiation is completely absorbed before it reaches the surface, and since most diagnostic procedures utilize crystal scintillation detectors that can accurately detect only γ radiation, β radiation contributes to radiation hazard without adding to the data obtained. Among γ-emitting radionuclides, some have more desirable characteristics than others. Scintillation counters are much more efficient in detecting γ rays of low energy; for γ rays of high energy, it is mandatory to use larger crystals, adding greatly to the cost, increasing the level of background radioactivity, and necessitating greater amounts of lead shielding. In studies that require a high degree of spatial localization in the body, the range of useful γ-ray energies is limited. Particularly in scintillation scanning, the requirements for both resolution and sensitivity necessitate multichannel lead collimators. With these collimators, high-energy radiations (>500 kev) are particularly troublesome since they penetrate not only the side-shielding of the crystal, but also the septa of the collimators, thereby decreasing resolution. At the other extreme, γ rays with very low energy, like β radiation, are absorbed by the tissues before they reach the surface, and tissue absorption introduces errors in quantitation. It is predicted that β-emitting radionuclides will be used increasingly in the future, since many of the most important body constituents can be labeled only with hydrogen, carbon, sulfur, calcium, and phosphorus isotopes. As a result of improved instrumentation, it will soon be possible to apply to diagnostic medicine the techniques now available to the biochemist for animal studies. The following special pharmaceutical problems associated with use of radioisotopes are discussed: problems of carrier-free state, i.e., those arising because of the extremely small chemical quantities; problems of self-decomposition, produced by the effect of radiation on the compound itself or on its solvent; problems resulting from isotope effect, i.e., differences in reaction rates that sometimes result from differences in atomic wt of isotopes; and problems resulting from chemical differences between labeled and naturally occurring compounds. Use of individual isotopes in diagnosis in renal, cardiovascular, gastrointestinal, thyroid, and gastrointestinal disease is outlined. (BBB)

39325 WORK IN A RADIOACTIVE ENVIRONMENT AND ITS PROBLEMS. J. Rodier, R. Estournel, H. Bouzigues, and J. Chassany. Energie Nucl., 5: 291-300(June 1963). (In French)

The precautions taken at Marcoule to prevent incidents with radioactivity are described. The prevention of external irradiation and contamination (penetration of the radioactivity into the workers' bodies) and the monitoring of radioactivity released during waste removal are discussed. A complete training program for the personnel strengthens the precaution program. (J.S.R.)

39326 SKIN INJURY BY MEANS OF GAMMA RADIATION FROM THE TELEVISION TUBE? H.-D. Jung (Poliklinik, Neubrandenburg, Ger.). Gesundheitswesen, 16: 253-8(Feb. 9, 1961). (In German)

The possibility of skin damage from γ radiation produced by television tubes is evaluated. The damage might result in persons working in factories producing television sets. The case is described of a television repair mechanic with spotty pigmentation on his face which he claimed was caused by γ radiation from television receivers. Grey-brown to grey-black spots were present on his cheeks, nose, mouth, and chin but his forehead, bridge of nose, and eyes were free of such lesions. Spectacles and wide protective glasses were worn constantly when at work. Sensitized films were attached to forehead and cheeks and left in place several days during work hours. The films showed no radiation exposure. A check run on the television tubes themselves at his workshop gave negative results. The patient's condition worsened, and skin tests revealed sensitivity to a cosmetic preparation. Thus, possibility of skin damage resulting from television tubes was positively ruled out. The radiation dose in this case could not have exceeded 0.03 rad/week. (BBB)

39327 ON THE CALIBRATION OF DK-02 AND KID DOSIMETERS. H. Ehvaert (Inst. for Experimental and Clinical Medicine, Academy of Sciences, Estonia SSR). Izv. Akad. Nauk Est. SSR., Ser. Biol., No. 2, 128-31(1963). (In Estonian)

For the periodic calibration of the DK-02 and KID dosimeters, the rotating stand method which is more advantageous than the usual method is recommended. The calibration can be accomplished in a strong gamma field, reducing considerably the time necessary for calibration. Using a point source, the dose becomes a simple function of time and geometrical parameters. The experi-

mental values are in good agreement with theoretical values. (tr-auth)

39328 REDUCTION OF ATMOSPHERIC RADIOACTIVITY LOSSES BY ION EXCHANGE AT THE FLASK WALLS. W. Marquardt. Kernenergie, 6: 441-2(Aug. 1963). (In German)

Reduction of activity losses by ion exchange by the walls of metal, glass, and porcelain vessels in monitoring of fallout is discussed. (M.C.G.)

39329 HAZARDS OF X RAYS. Francois Dupré la Tour (Faculté Française de Médecine, Beirut, Lebanon). Lebanese Med. J., 15: 129-41(May 1962). (In French)

39330 THE MEDICAL PROBLEMS OF NUCLEAR WAR. Einer W. Johnson, Jr. (Mayo Clinic, Rochester, Minn.). Minn. Med., 45: 118-23(Nov. 1962).

Casualty estimates resulting in a nuclear attack are discussed in relation to the number of medical personnel and extent of hospital resources available. Organization of medical facilities is discussed, with reference to problems encountered in specific civil disasters, and educational programs for civil defense preparedness are also dealt with. (BBB)

39331 PLANNING FOR HOT [RADIOACTIVE] FIRES. Frances L. Brannigan and George S. Miles. Natl. Safety News, 87: No. 5, 18-19; 170; 172; 203(May 1963).

An outline for prefire planning between the fire department and plant management is presented. Things to do in all cases, in case of external radiation hazard, in case of internal radiation and contamination hazard, and nuclear accidents are listed. (P.C.H.)

39332 PRESENT LEVELS OF RADIOACTIVE FALLOUT. T. Magnusson (Research Inst. for National Defense, Stockholm). Nord. Hyg. Tidskr., 43: 27-30(1962). (In Swedish)

Fallout levels and radioactivity content of air are reported for numerous Swedish communities as measured in the latter half of 1961. The fallout level early in December, 1961, varied from 0.5 to 45 mC/km^2 and the radioactivity of air from 2 to 5 $\mu\mu$C/m^3. Peak activities of air measured in Stockholm over the 6-month period reached max levels of ~12 $\mu\mu$C/m^3 early in October and the middle of November, 1961. Fallout reached a max of 115 mC/km^2 on November 12, 1961. Data for various communities for July to December, 1958, are also given. (BBB)

39333 PUBLIC HEALTH AND THE RADIATION HAZARD. H. Gardner Bourne, Jr., James C. Wynd, and Ralph E. Dwork (Ohio Dept. of Health, Columbus). Ohio State Med. J., 58: 1036-9(Sept. 1962).

Measures in use or being considered by the Ohio Dept. of Health to reduce radiation hazards, particularly from fallout radionuclides and from excessive medical and dental diagnostic exposure, are discussed. The extent of contamination of Ohio milk with radiostrontium, cesium, and iodine has been a source of apprehension. However, more important in attempts to halt the upward trend in exposure to radiation is reduction of exposure in radiodiagnosis. The individual physician or dentist is the appropriate responsible agent who must weigh benefit against risk, and this right of the physician or dentist is guaranteed in the statutes which do not limit the kind and amount of radiation that may be intentionally applied to a person for diagnostic or therapeutic purposes by or under the direction of a physician or dentist. To fulfill this responsibility the following precepts are recommended: There should be clear-cut clinical indications before any x-ray examination is undertaken, and it should be ascertained whether there has been a previous radiological examination which would make further examination unnecessary. There should be consultation between clinician and radiologist before extensive or repeated radiological examinations of young individuals are undertaken. To reduce repeat studies, strict attention should be paid to adequate preparation before abdominal investigation. Special precautions should be adopted in radiography of pregnant women. Previous history of radiotherapy should be ascertained before a new course of treatment is undertaken. Radiotherapy should not be employed in benign conditions which respond to other types of treatment. Specific ways of reducing exposure during radiologic and fluoroscopic tests are also considered. (BBB)

39334 FILTRATION FOR LOWEST PATIENT DOSE IN DENTAL RADIOGRAPHY. W. W. Wainwright (George M. Hollenback Research Associates, Encino, Calif.). Oral Surg., Oral Med., Oral Pathol., 16: 561-71(May 1963).

Criticisms are advanced against attempts to avoid unnecessary radiation exposure by adoption of state regulations requiring added filtration in order to absorb the soft x-rays of the beam presumably to spare the patient this part of the radiation exposure. The general adoption of increased filtration is regrettable, it is suggested, since its usefulness applies only to specific conditions and does not reduce radiation exposure in large areas of radiography. This investigation analyzes: the filtration recommendations of the National Bureau of Standards Handbook 76, the measurements on which the recommendations are based, and the results of further measurements in dental radiography. Conflict of the Handbook 76 recommendations with those of the (British) Medical Research Council's Second Report are discussed. Filtration should be increased with increase of kilovoltage, according to the Handbook, but the Report suggests that the gonad dose in dental radiography may be slightly increased by the use of higher penetrating powers. To reconcile these divergent recommendations, a comparison is made of the methods and the criteria of patient dose upon which they are based. A heavily boned adult male skull was impregnated with paraffin and the phantom was mounted with an ionization chamber in the headrest of a dental chair. Measurements in the phantom and in the gonadal position were made at an arbitrary distance of 26 in. from the beam. Measurements were made at total filtrations equal to 1.5, 2.0, 2.5, 3.5, 4.5, and 5.5 mm aluminum for kilovoltages of 90, 65, and 45. Measurements of film dose were also made in a second phantom constructed of aluminum and air. Dental film dose was shown to be constant for a given film, regardless of change in kilovoltage or half-value layer. The results showed that the recommendation that filtration and kilovoltage be increased to reduce patient dose is applicable only to situations in which the gonads lie unprotected in the direct beam. When the gonads lie outside the direct beam, as in dental radiography, an increase in filtration or kilovoltage reduces skin dose and depth dose only up to the depth of 1 in., which is the plane of the film. Beyond this there is a reversal in which the patient dose is increased by an increase in filtration or kilovoltage, and the gonadal dose is unaffected. Increases in filtration or kilovoltage do not decrease the patient dose in dental radiography when an effort is made to keep gonad, skin, and integral doses as low as possible. In vivo gonadal exposures, measured on male subjects without protective aprons in two dental offices, were shown to decrease roughly in proportion to the sitting height, so that exposures in boys as young as 4 or 5 yr of age are two to three times greater

than in adult males. In obese persons whose thighs were so large as to completely cover the measuring chamber, gonadal measurements were much lower than in persons of average build. The gonadal doses per set of 20 films varied from 0.3 to 3.7 mr. The in vivo measurements were higher than the measurements on the phantom, presumably because of differences in physical arrangement. (BBB)

39335 DENTAL RADIATION DOSE: SENSITOMETRIC METHOD FOR DETERMINATION OF EXPOSURE-DEVELOPMENT FACTORS. W. W. Wainwright (George M. Hollenback Research Associates, Encino, Calif.). Oral Surg., Oral Med., Oral Pathol., 16: 674-82(June 1963).

It is suggested that film speed is the most important single factor in reducing dental radiation exposure but has been given little attention. A necessary step in this direction is the application of quantitative film rating systems (of the type used in general radiography) to dental radiography and attention to exposure development factors. To this end, a sensitometric method is presented for measurement of undesired dental radiation overexposure resulting from underdevelopment. The method is based on a universal curve of density-log relative exposure for dental x-ray film. The curve is applicable to any given film and machine setting in intraoral roentgenography. Correct exposure time can be predicted from the curve after exposure of only two dental films and use of a lead-aluminum penetrometer. This dental penetrometer and the universal sensitometric curve make it possible to conduct mass surveys of the amount of radiation overexposure from exposure-development factors in dental offices. An example of a typical determination of the effect of exposure-development factors on radiation dose is given. The densities were measured with a densitometer in the range from 0 to 6. With an exposure of $\frac{1}{2}$ sec and development for $1\frac{1}{2}$ min at 64°F, the hypothetical dentist obtained a density of 1.95 under aluminum. Full development gave a much greater density, 4.05, which was found by reference to the universal curve to represent a radiation exposure of 3.5 times normal. In other words, the underdevelopment ($1\frac{1}{2}$ min at 64°F) was compensated by overexposure ($\frac{1}{2}$ sec), so that films of normal density could be obtained. The dentist was informed of the overexposure, and it was predicted that by dividing his time ($\frac{1}{2}$ sec) by the radiation exposure (3.5), with full development, he would be able to reduce exposure time from 0.5 to 0.143 sec. On the corrected film with an exposure time of 0.15 sec, the density is 1.72. By changing to full development, the dentist obtained normal density with $\frac{1}{3}$ the amount of radiation. (BBB)

39336 DIET OF INFANTS AND CHILDREN IN DISASTER. Ogden C. Bruton. Pediat. Clin. North Am., 9: 1025-31(Nov. 1962).

Plans are proposed for feeding infants and children in case of thermonuclear attack. Plans can be made on every level from the national down through the individual family, the family being a most important link in the chain. The goal would be to have the nutritional needs of the infant uninterrupted. It is mandatory that each family with an infant under one year of age stock at least a 2-week supply of food for the baby, including milk (liquid or dry) and other foods (canned) normally used in infant feeding. Water, at least 2 qt/day, should be provided on the same basis. The possibility of not being able to sterilize water by the usual methods makes the use of iodine or chlorine practical and necessary. Sterilization methods are described, including use of purification tablets, iodine (ordinary household tincture, 6 drops/qt of clear water or 10 drops for cloudy water) and chlorination (achieved by adding 10 drops of any ordinary household bleaching solution containing sodium hypochlorite/gal of water). Materials necessary for one of these methods of sterilization should be included with the other store of supplies. Although radioactive contamination of food and water after nuclear attack will be a serious concern, food in sealed, unbroken packages, cans, or jars will be safe for consumption if the exterior of the container is wiped or washed. Much radioactive contamination in water may be removed by simply allowing the water to settle and then straining it through a paper towel or a fine-mesh cloth. Breast feeding under disaster circumstances would be desirable. The daily basic nutritional needs of infants toward which emergency food plans should strive to provide are tabulated. Minimum requirements are about $\frac{2}{3}$ of basic requirements and could prevent real disaster from the nutritional viewpoint in infants. If essential nutrients are obtained from such foods as milk, cereal, and potatoes, other vitamins and minerals should be supplied in quantities to meet minimum requirements. For prolonged emergencies (>30 days), vitamin C will become an important factor. (BBB)

39337 COSMIC FLIGHTS AND IONIZING RADIATION. A. V. Lebedinskii and Yu. G. Nefedov. Priroda, No. 7, 19-24(July 1963). (In Russian)

Biological effects and permissible doses of ionizing radiation in cosmic flights in manned vehicles are discussed. (R.V.J.)

39338 RADIATION MEDICINE AND PEDIATRICS. Robert L. Cranny (Albany Medical Coll., Albany, N. Y.) and Lee E. Farr. Quart. Rev. Pediat., 16: 10-13(Jan.-Mar. 1961).

Precautions attendant to the use of radioisotopes in pediatric diagnostic problems are considered. The general value of isotopes in pediatrics appears to be mainly as a precise diagnostic and research tool, but at present full advantage cannot be taken of this. Owing to the risk involved, these materials should not be administered to infants until the procedures are soundly established and the undesirable effects clearly delineated. However, to proscribe radioactive isotopes for children would deny them advantages of recent medical advances. This difficulty will be lessened with the continued development of supersensitive and highly specific instruments for detection of minute amounts of radioactivity and adaptation of these instruments to the geometry and other conditions made necessary by a child's size and activity. (BBB)

39339 THE LIMITATION OF THE RADIATION DOSAGE TO THE PATIENT IN DIAGNOSTIC RADIOGRAPHY. Daniel Graham (Victoria Infirmary, Glasgow). Radiography, 27: 345-53(Oct. 1961).

Means of reducing patient exposure are discussed with particular reference to modifications of the x-ray apparatus and technique and of the organization of radiology departments. Modification of the apparatus, especially of the tube head, emergent beam, filtration, and collimation, is outlined and specific examples of correction resulting in reduced patient doses are cited. Techniques and appliances for direct gonadal shielding are described and illustrated. The influence of kilovoltage, focus-film distance, film sensitivity, and film development factors on exposure is surveyed and specific recommendations made. The organization and design of the x-ray department has an indirect bearing on the limitation of radiation-dosage to the patient, and contributes greatly to protection by ensuring that the department works efficiently with little or no duplication of work.

Registration of all patients is most important of all, for a complete record of previous exposures. (BBB)

39340 RADIOACTIVE FALL-OUT, ITS DISPERSION, DEPOSITION OVER SOUTH AFRICA AND BIOLOGICAL SIGNIFICANCE. W. R. McMurray (National Physical Research Lab., Pretoria) and L. O. Stander. S. African J. Sci., 59: 19-30(Jan. 1963).

The dispersion and deposition of radioactive debris from Russian tests are briefly discussed. Measurements of deposition over South Africa are summarized. The information was analyzed to enable estimates to be made of the radiation dose-rates in South Africa to critical organs of the body— in this case the gonads (0.5 mr/year) and the bone marrow (1.5 mr/year). These were compared with fallout dose-rates obtained in the Northern Hemisphere and the average dose-rate from natural sources (about 100 mr/year). (P.C.H.)

39341 THE PLANCK AND THE RAD: A MODERN VIEW OF PROBLEMS IN RADIATION MEASUREMENT. H. R. Schinz and R. Wideroee. Schweiz. Med. Wochschr., 93: 837-8(June 15, 1963). (In German)

The conclusions (Report 10a) of the International Commission on Radiological Units and Measurements (ICRU) for clarification of radiation unitage are discussed, and the establishment of a new special unit (the planck) for the density of radiation is proposed. This new unit corresponds to the term energy-fluence referred to by the ICRU report for a field of quantum or particle radiation. The new unit is defined as: 1 planck = 3000 erg/cm^2. It would be applicable to all measurements of the radiation field, i.e., for radiometry; e.g., 1 planck per sec (1 P/sec) referring to radiation intensity. With the present unitage there is ambiguity between measurement of radiation density (radiometry) and dosage (dosimetry), since certain methods of measurement, such as by ionization chambers, are used for both entities and the roentgen unit to characterize both field density and dose. The rho unit is also based on ionization measurements, and it is proposed that the rho and roentgen units both be regarded as supplementary units for special measurements and used as intermediates in evaluation of planck and rad values. The rad (= 100 erg/g) was established in 1953 as a special unit for absorbed dose. Thus, by use of the planck for radiometry and the rad for dosimetry, nearly all radiologic measurements are covered. Although the roentgen and rho may have numerical values similar to those of the other units, they cannot be identified with these basic units. Over the energy range 0.2–1 Mev the roentgen value, measured by ionization will deviate less than 8% from the planck value, and the rho value over the range 0.2–30 Mev will also deviate less than 8% from the rad value. (BBB)

39342 ON THE APPEARANCE OF A SECONDARY ELECTRON RADIATION IN IRRADIATION WITH THE ULTRAHARD X RADIATION OF THE BETATRON. Iwao Azuma (Universität, Erlangen-Nuremberg, Ger. and Universität, Gissen, Ger.). Strahlentherapie, 122: 37-40 (Sept. 1963). (In German)

Measurements done with a 18-Mev-betatron of the Siemens-Reiniger-Werke are reported. They show that ultrahard x-ray radiation is accompanied by a secondary electron radiation that is scattered beyond the collimated beam. (auth)

39343 EXPERIMENT IN INTERNAL DOSIMETRY WITH THE HELP OF THE THERMOLUMINESCENCE METHOD AFTER INCORPORATION OF Sr^{90} IN RATS. Heinz Kriegel, Norbert Haering, and Guenther Neumann (Heiligenberg-Instituts, Heiligenberg, Ger. and Technische Hochschule, Munich). Strahlentherapie, 122: 41-7(Sept. 1963). (In German)

The use of the thermoluminescence method for dose measurements after Sr^{90}-incorporation was tested in a biological experiment using rats. There is a linear relation between the administered Sr^{90}-dose and the radiation dose measured in the abdomen of the rat with a CaF_2-dosimeter. The absolute dosage was determined by means of a calibration instrument for the experimental conditions. The results are discussed and continuation of the experiments with an improved dosimeter and evaluation instrument is announced. (auth)

39344 SIGNIFICANCE OF RADIATION HAZARDS TO PUBLIC HEALTH AND THE DUTIES OF HEALTH OFFICIALS IN THIS REGARD. P. Muntedam (Volksgezondheid, Hague). Tijdschr. Sociale Geneesk., 40: 391-6(July 6, 1962). (In Dutch)

39345 AIR POLLUTION: RESEARCH AND CONTROL. J. W. Tesch. Tijdschr. Sociale Geneesk., 40: 477-8 (Aug. 24, 1962). (In Dutch)

Fallout problems related to human health are discussed. (BBB)

39346 MATHEMATICAL PROGRAMMING MODELS FOR SELECTION OF DIETS TO MINIMIZE WEIGHTED RADIONUCLIDE INTAKE. Jerome Bracken (National Bureau of Standards, Washington, D. C.). U. S. Public Health Serv., Publ. 999-R-4, 18p. (Aug. 1963).

Some motivating and background material underlying the formulation of the models is presented. Several mathematical programming models for selecting diets to minimize radionuclide intake are formulated, of which the most attractive seems to be for minimizing linearly weighted radionuclide intake. An example is given of the application of one of the models using published data of radionuclide content of foods. (auth)

39347 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME IV, NUMBER 7. (Public Health Service, Washington, D. C.). July 1963. 62p. $0.50(GPO). (RHD-Vol.4, No. 7)

Data are reported on radioactivity in samples of food, milk, water, and air collected throughout the U. S. during 1962 and 1963. Data are included on airborne radioactivity in Canada and Mexico, radiation levels aboard commercial jet aircraft resulting from atmospheric nuclear weapons tests, and Sr^{90} content in soil and bone samples. Levels of environmental radioactivity at Knolls Atomic Power Lab. during the second half of 1961 and first half of 1962 and the SIC Prototype Reactor Facility during the second half of 1961 and first half of 1962 are reported. A summary is included of nuclear detonations reported during June 1963. (C.H.)

39348 EXPOSURE OF MAN TO RADIATION IN NUCLEAR WARFARE. A Series of Lectures held at the Conference of the NATO Civil Defense Committee, Scientific Working Party, June 20 and 21, 1961 at the Permanent Headquarters of NATO, Paris. John H. Rust and D. J. Méwissen, eds. Elsevier Monographs. Medicine Section. Amsterdam, London, and New York, Elsevier Publishing Company, 1963. 162p. $2.75.

Separate abstracts were prepared on 6 papers presented at this conference. A panel discussion is included. (C.H.)

39349 EMERGENCY EXPOSURES. George V. Leroy (Univ. of Chicago). p.5-33 of "Exposure of Man to Radiation in Nuclear Warfare." Amsterdam, London, and New York, Elsevier Publishing Co., 1963.

The biological effects of whole-body γ irradiation of man are reviewed. The radiation dose from a theoretical thermonuclear attack is estimated, and the minimum amount of protection needed for survival is calculated for ranges of possible exposure assuming that people remain in shelters during the entire 48 hr following the beginning of fallout. Radiation exposure due to nuclear accidents is also considered. It is pointed out that in a thermonuclear war the majority of people will be exposed to relatively large initial doses of radiation during the first few days and protracted radiation doses for a time that is difficult to predict. The equivalent residual dose (ERD) is recommended as the basis for evaluating exposure and as a guide in decision making. It is assumed that when the ERD is less than 200 r medical care will not be required, between 200 and 600 r there will be some casualties, and the majority of those who receive more than 600 r will die. Procedures for calculations of the ERD at any time are discussed. (C.H.)

39350 NUCLEAR THREAT AND HUMAN GENETICS. L. L. Cavalli-Sforza (Università, Pavia, Italy and Università, Parma, Italy). p.34-49 of "Exposure of Man to Radiation in Nuclear Warfare." Amsterdam, London, and New York, Elsevier Publishing Co., 1963.

Data on the genetic effects of radiation are reviewed. It is pointed out that it is impossible to estimate the genetic damage that might result from a nuclear attack since there are difficulties both in estimating mutation rates for man and in estimating the average radiation dose for survivors. (C.H.)

39351 THE ASSESSMENT OF THE LEUKEMIA RISK IN IRRADIATED HUMANS. D. J. Méwissen (Université Lobre, Brussels). p.50-72 of "Exposure of Man to Radiation in Nuclear Warfare." Amsterdam, London, and New York, Elsevier Publishing Co., 1963.

Data on leukemia following irradiation of animals and man are reviewed. Statistical and experimental problems involved in the study of dose-response relations in leukemia are discussed. It is concluded that no threshold dose for leukemia induction by radiation has been established. (C.H.)

39352 GENETICAL EFFECTS OF RADIATION. A. C. Stevenson (Medical Research Council, Oxford). p.73-93 of "Exposure of Man to Radiation in Nuclear Warfare." Amsterdam, London, and New York, Elsevier Publishing Co., 1963.

The surviors of a nuclear disaster would be a very heterogeneous group in respect to dosage and therefore in respect to temporary or permanent sterility and transmissible damage induced in their germ cells. Possible genetic effects of radiation from a nuclear attack in human populations are discussed. (C.H.)

39353 HUMAN FERTILITY IN NUCLEAR WARFARE. J. A. H. Brown (Medical Research Council, Harwell, Berks, Eng.). p.94-108 of "Exposure of Man to Radiation in Nuclear Warfare." Amsterdam, London, and New York, Elsevier Publishing Co., 1963.

Nuclear warfare will result in the exposure of large numbers of the population to both acute and chronic irradiation. Data on the radiosensitivity of the reproductive system of males and females are reviewed. The effect of nuclear warfare on human fertility is discussed. It is concluded that exposure to radiation doses of the LD_{50} level will result in at least 1 or 2 yr of sterility after exposure, and smaller doses will produce some months of depressed fertility. Long-continued radiation from fallout will also produce sterility for some months. (C.H.)

39354 TREATMENT OF WHOLE-BODY RADIATION INJURY. H. Jammet (Nuclear Research Center, Paris). p.109-26 of "Exposure of Man to Radiation in Nuclear Warfare." Amsterdam, London, and New York, Elsevier Publishing Co., 1963.

Clinical symptoms of radiation sickness that may be used as a basis for estimates of the radiation dose reveived are reviewed. It is pointed out that in the event of nuclear warfare, neither time nor resources should be wasted on those who have no chance of surviving. No hospitalization should be necessary for those who have received less than 200 r of whole-body radiation. Between 200 and 400 r, ordinary support therapy should be sufficient, with transfusions of whole blood or of cellular concentrates used only when indicated. Bone marrow transplantations should be reserved for the treatment of patients who have received radiation in the lethal range up to 800 r. Since a single donor can provide bone marrow for only one patient, and a large number of trained staff and specialized equipment are required, the use of bone marrow transplantations should be reserved for those most likely to benefit. If the radiation dose exceeds 800 r, any treatment is doomed to fail. (C.H.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

39355 (AD-296593) USE OF ANTIBIOTICS AND/OR CHEMICAL ADDITIVES IN COMBINATION WITH RADIATION TO PRESERVE FRESH MEAT ITEMS. Report No. 13 (Final), April 11, 1956 to April 10, 1962. C. K. Wiseman, V. J. Kubala, J. G. Heck, A. C. Gretler, L. A. Harriman, R. G. Gordon, J. J. Berky, and F. J. Alexander (Armour and Co., Chicago). Contract OMR&E (NATICK) 38. 86p.

The flavor of fresh ground beef is sensitive to the action of irradiation. Irradiation, when used alone in doses that cause little flavor change, will decrease the total bacterial count by about 90%, but the shelf life at 40°F is not greatly extended. Aureomycin, when used in low concentrations, will delay the growth of the survivors. The combined treatment could be used to produce products with good shelf life and very slightly altered flavor from meats that, because of flavor radiosensitivity, cannot be treated satisfactorily with higher doses. Substerilization levels of radiation have been shown to increase the refrigerated shelf life of pork, beef, and sausage items. Results also show that increases in dosage also increases the shelf life of the product. Pasteurization of suitable products by means of irradiation offers possibilities for increasing the shelf life of these products. The present studies do not present differences as dramatic as those shown in the past, but do indicate the effectiveness of this method of preservation. Although the results indicate that formulation changes are needed (spice), there appears to be no objectionable off-flavors in the products due to irradiation. (auth)

39356 (AED-C-05-03) AUSGEWÄHLTES SCHRIFTTUM NACH SACHGEBIETEN. STRAHLENKONSERVIERUNG UND KONTAMINATION VON LEBENSMITTELN. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected Literature According to Subject Field. Radiation Preservation and Contamination of Food. Bibliographic Compilation). U. Schuetzsack, comp. (Gmelin-Institut für Anorganische Chemie und Grenzgebiete, Frankfurt am Main). Mar. 1963. 169p.

References (605) are given to U. S. and foreign journals and reports published from 1956 through 1962. Separate author and subject indexes are included. (P.C.H.)

39357 (AED-C-12-06(Pt.I)) AUSGEWÄHLTES SCHRIFTTUM NACH SACHGEBIETEN. OSTLITERATUR DER KERNWISSENSCHAFTEN. ANWENDUNG VON RADIONUKLIDEN IN INDUSTRIE UND FORSCHUNG. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected Literature According to Subject Field. Literature of the East on Nuclear Sciences. Use of Radionuclides in Industry and Research. Bibliographic Compilation). Benno Ensslen and Rolf Paul (Kernforschungsanlage, Jülich, Germany). June 15, 1963. 206p.

References (966) are given to U. S. and foreign journals and reports published from 1957 through 1962. Separate author and report number indexes are included in part II. (P.C.H.)

39358 (AED-C-12-06-II) AUSGEWAHLTES SCHRIFTTUM NACH SACHGEBIETEN. OSTLITERATUR DER KERNWISSENSCHAFTEN. ANWENDUNG VON RADIONUKLIDEN IN INDUSTRIE UND FORSCHUNG. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected Literature According to Subject Field. Literature of the East on Nuclear Sciences. Uses of Radionuclides in Industry and Research. Bibliographic Compilation). Benno Ensslen and Rolf Paul (Kernforschungsanlage, Jülich, Germany). June 15, 1963. 213p.

References (780) are given to U. S. and foreign journals and reports published from 1957 through 1962. Separate author and report number indexes are included. (P.C.H.)

39359 (BMI-1648) INDUSTRIAL ENVIRONMENTAL CONDITIONS OF SEALED RADIATION SOURCES. Robert A. Ewing, Peter Gluck, Harvey B. Brugger, James E. Drennan, and Duane N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). Sept. 10, 1963. Contract W-7405-eng-92. 48p.

The characteristic environmental conditions under which sealed radiation sources are utilized industrially were delineated by on-site surveys conducted at 57 representative plants, comprising 18 different industry categories. Potential abnormal environments to which sealed sources might be subjected were also evaluated for each industry. In connection with establishing parameters for safety performance tests for normal environments, the feasibility of accelerated test procedures was evaluated. Observed normal environmental conditions were evaluated as not posing a serious threat to the integrity of most sealed sources used industrially. Potentially possible abnormal environmental stresses, principally fire or explosion, were judged to be more likely to induce source failure, although the probability of such incidents is low in the usual industrial application. (auth)

39360 (TID-17886) ECONOMIC FEASIBILITY OF RADIATION-PASTEURIZING FRESH STRAWBERRIES, PEACHES, TOMATOES, GRAPES, ORANGES, AND GRAPEFRUIT. John H. Droge (Department of Agriculture. Economic Research Service, Washington, D. C.). Aug. 1963. Contract AT(49-11)-2085. 29p. (ERS-131)

Results are reported from a survey of the produce industry on the feasibility of using radiation processing to extend the storage life of fresh strawberries, peaches, tomatoes, grapes, oranges, and grapefruit. A majority of the respondents thought that radiation processing would increase the production and market volume of the selected fruits and vegetables surveyed but would not change output and sales volume of canned, frozen, and other processed forms. Cost estimates of radiation processing are discussed. (C.H.)

39361 AUTOMATIC CONTROL INSTRUMENTS BASED ON RADIOISOTOPES FOR THE CHEMICAL INDUSTRY. S. Margolinas. Dechema Monograph., 43: 347-51(1962). (In German)

A description is given of a number of instruments for measuring density, level, and sulfur content intended for use in the chemical and petrochemical industries. The instruments are based on the absorption properties of matter for radiation emitted by radioactive sources. (auth)

39362 INDUCTION OF MUTATIONS FOR RUST RESISTANCE IN WHEAT. C. Bhatia, M. S. Swaminathan, and N. Gupta (Indian Agricultural Research Inst., New Delhi). Euphytica, 10: 379-83(1961). (In English)

To test the possibility of artificially inducing resistance to rust in a susceptible wheat and to ascertain whether the dominance or recessiveness of the resistant reaction influences in any way the observed result, M_2 and M_3 progenies of the bread wheat variety C 591 treated with different mutagens were screened for resistance to races 21, 40, and 42 of stem rust. C 591 is a fully awned spring wheat characterized by a good quality of grain but high susceptibility to rusts. Seeds were collected from M_1 plants after the following treatments: 11000 and 16000 r of x rays; fast neutrons given for 3.5 and 6 hr at a flux of $10^9 N/cm^2/sec$; thermal neutrons given for 41.4 min at a flux of $8 \times 10^9 N/cm^2/sec$; and P^{32} applied to pots at 25 and 50 μc per plant. In the M_2 population tested, no seedling with a reaction to rust different from that shown by the controls was observed. Some of the progenies of treated plants segregated for albinos. No infection was observed in the albino mutants, though repeated inoculations were carried out and the albinos survived for a period longer than the incubation time required by the pathogen (i.e., about 10 days after inoculation). Some M_2 plants belonging to families treated with 16000 r of x rays were fairly free of rust infection, so 5 such plants were bagged and seeds were collected from each of them separately. When the M_3 progenies raised from them were tested for resistance in the seedling state to races 15c, 24 and 40 of stem rust, it was found that one family was immune to race 40 (0 type of infection). About 100 plants of each of these families were raised and shown to be uniform in morphologic characters and resemble the parent strain in all respects except in the color of glumes and rust resistance. The close similarity between the mutant and the parent variety in plant habit, maturity, grain quality, ear, and awn characters, as well as its true breeding nature, indicates that it could not have arisen through chance out-crossing. This mutant had brown glumes in contrast to the white glumes of the parent strain. The susceptibility of C 591 to race 40 of stem rust appears as a recessive character in crosses with resistant varieties. The mutation conferring resistance should hence be technically regarded as belonging to the rare class of dominant mutations. In bread wheat, however, it is difficult to establish dominance relations for many loci accurately, hence it would be premature to classify the mutant as a dominant one. No other mutant was found after the radiation treatments, although albino seedlings were totally free of rust infection. It is concluded that mutations for rust resistance can be induced in bread wheat by ionizing radiation but that the frequency of such mutations is very low, occurring only in a few of the 25,000 seedlings tested. (BBB)

39363 EFFECT OF GAMMA RADIATION, CHEMICAL, AND PACKAGING TREATMENTS ON REFRIGERATED LIFE OF STRAWBERRIES AND SWEET CHERRIES. G. M. Cooper and D. K. Salunkhe (Utah State Univ., Logan). Food Technol., 17: 123-6(June 1963).

After preirradiation chemical treatments and/or packaging in films, the fruits were sealed in perforated cans and irradiated at the Materials Test Reactor Station, Arco, Idaho, with spent-fuel rods of U^{235}. The doses were: strawberries 1, 2, and 3×10^5 rad; and cherries 2, 3, and 4×10^5 rad. Fruits were aerated during irradiation and then placed in storage at 40°F and 80% relative humidity for various periods. The cans were then opened; the percentage of marketable fruits was calculated, and fungi infecting the fruits were identified. The following results were obtained with strawberries. A dose of 2×10^5 rad was optimum for radiopasteurization; shelf-life was extended ~15 days at this dose. At the high (3×10^5-rad) dose, breakdown of tissue caused the berries to have a spongy, water-soaked texture. Captan proved a better fungus-inhibiting chemical than potassium sorbate when used with radiation. Hormodendrum and Botrytis were the most common fungi; Penicillium was killed in all irradiated treatments. Varieties such as Kasuga, Lindalicious, and Sparkle, when harvested at the firm-ripe stage of maturity and then irradiated kept better than other varieties. With sweet cherries it was found that a dose of 3×10^5 rad was effective in extending shelf-life beyond 30 days. Cherries turned brown at the high (4×10^5-rad) dose; however, pigment development and ripening were progressively retarded in all irradiated samples. Fungus control was better with Myprozine, captan, and Mycostatin than with other chemicals used with radiation. Storage life increased significantly when Mylar packaging was combined with radiation and chemical treatments. Alternaria was the most prevalent fungus growth; Penicillium was not observed. Bing, Lambert, and Windsor varieties responded better to radiopasteurization than did Napoleon. With some varieties of cherries, deterioration of the fruit was greater after low doses than in the absence of irradiation, which indicates that radiation causes certain physical or chemical changes in some varieties thus enabling fungi to grow readily. At lower doses, this effect apparently fosters fungus growth sufficiently to more than compensate for the fewer organisms present initially. At higher radiation doses, the probability of eliminating all fungi increases, and more fruits may be totally free of fungus regardless of growth-promoting factors. It appeared that Penicillium mold is inhibited by γ radiation, and that the main causes of decay at higher doses were the multicellular-spored fungi, which have greater resistance to γ radiation than the unicellular conidia of Penicillium. (BBB)

39364 A BIOLOGICAL AFTER-EFFECT IN RADIATION-PROCESSED CHICKEN MUSCLE. Myron Solberg (Colonial Provision Co., Boston) and John T. R. Nickerson. J. Food Sci., 28: 243-4(May-June 1963).

Chicken muscle samples were exposed to six Mrad in a 2-Mev Van de Graaff particle accelerator, for a period of only a few minutes. Other samples were exposed to six Mrad of γ irradiation in a Co^{60} source for ~36 hr. The treated samples were then inoculated with Staphylococcus aureus, and at intervals, up to 10 hr after inoculation, bacterial counts were made on the meat to determine its ability to support bacterial growth. No significant differences were found between the two irradiated samples, indicating an absence of a dose-rate effect. The effect of the holding time between irradiation and inoculation was also investigated. When a 14-hr period elapsed between completion of the radiation exposure and inoculation of the samples, the adjustment phase was slightly longer than on the control samples but was substantially reduced when compared with samples inoculated immediately after exposure. The logarithmic phase growth on the irradiated chicken tissue followed the same slope as that eventually assumed by the organisms inoculated immediately after radiation exposure. It appeared that the inhibitory effect declined as the time between exposure and inoculation was increased. Thus, the similarity of the inhibitory effect on bacterial growth in irradiated chicken tissues subjected to widely varying dose rates indicates a continual, dose-dependent build-up of the inhibitory mechanism without any dissipation as long as the radiation dose was being applied. The loss of the inhibitory effect after removal from the energy source appeared to be first order. The results suggest the possibility that foods might be preserved for short periods by applying low-dose-rate radiation, the energy input of which

is just sufficient to maintain the balance of the inhibitor, even though some decomposition of the inhibitor might occur during the exposure period. This dose rate may be of such magnitude that the energy available will be insufficient to initiate the chemical reactions that cause off-flavors in foods. Hence, this technique may represent a food-storage device similar to a refrigerator but requiring only a low-level source of ionizing radiation as its operating mechanism. (BBB)

39365 ON A NEW SOURCE OF X RAYS. William G. Myers (Ohio State Univ. Health Center, Columbus). Ohio State Med. J., 58: 772-3(July 1962).

Use of I^{125} as a point source of x rays for radiography is described. Because I^{125} is a source of characteristic x rays almost entirely, and the energy for the creation of them is nuclear in origin instead of extranuclear, I^{125} is proposed as a new source of x rays. Calculations indicated that about 95% of the 144 photons emitted in each 100 disintegrations, in the narrow low-energy range of 27.2–35.4 kev, are the characteristic K x rays of tellurium which follow electron capture and internal conversion processes. Potential energy stored temporarily in the I^{125} nucleus thus becomes manifest predominantly in the form of x rays during decay that occurs with a half-time of 57.4 days. The I^{125} x-ray point source can be used to produce radiographs by transferring highly concentrated I^{125} as iodide, contained in ~0.1 ml N NaOH, into the tip of a long, thin (plastic needle-guard) tube, with an internal diameter near the tip of 1–2 mm. The I^{125} solution, which extends only a few millimeters up the long axis of the tube, is held in place by capillarity, and the open end is plugged with a small cork to prevent loss by evaporation. This little I^{125} x-ray device weighed about a gram, and obviates high-tension wires and other electrical apparatus used in conventional roentgenography. It is readily stored in lead foil. The exposure required for a radiograph of the hand is about 5 Curie-minutes when the source is 50 cm from the hand. This unit of exposure was contrived to demonstrate the practicability of fabricating I^{125} x-ray machines when this radionuclide becomes available in large quantities. It indicates the reciprocal relation between the strength of source and time required to make a satisfactory radiograph. The same radiograph can be made at the same geometry in 1 min with 5 C of I^{125} in the source, or in only 3 sec with 100 C. The excellent quality of radiographs so obtained are due not only to photoelectric absorption of the 27.2–35.4 kev photons in bone, but also the soft structures are revealed in detail because most of these photons are absorbed by the all-or-none photoelectric process in water as well, so that scattering by Compton interactions is greatly diminished. Also, the sensitivity of films is near max for photons having these energies. This may be due in part to resonance absorption because the energies are only slightly above the 25.5-kev K edge of the silver in emulsions. Calculations indicate that the high specific activity of I^{125} will permit preparation of point sources containing several Curies, or perhaps even up to a few hundred Curies, and at reasonable costs. Such a source, as palladous iodide, PdI_2^{125}, is presently being prepared and should be sufficiently strong to enable construction of a practical portable I^{125} x-ray machine not weighing more than a few pounds, and providing radiographs in less than a minute. The value of such a device for military, surgical, industrial, and geophysical applications is discussed. (BBB)

39366 PRESERVATION OF MEAT BY IRRADIATION. Ivan Yordanov. Vet. Sbirka, 60: No. 5, 19-24(1963).

The cold sterilization of meats and related products is discussed, including: elements of radiation measurement; effects on meats; precautions; doses required; and effect on microbes, trichinae, cysticercus, and other parasites. (TCO)

39367 APPLICATIONS OF NUCLEAR RADIATION TO TEXTILE MATERIALS AND PROCESSES. RADIATION-INDUCED GRAFT COPOLYMERIZATION OF VINYL MONOMERS AND FIBROUS POLYMERS. A. A. Armstrong, Jr. and H. A. Rutherford (North Carolina State Coll., Raleigh). Vienna, International Atomic Energy Agency, 1963, Preprint Paper CN-14/20, 40p. (CONF-194-1)

From Conference on the Application of Large Radiation Sources in Industry, Salzburg, Austria, May 1963.

A technique was developed that permits the radiation grafting of volatile vinyl monomers to fibrous polymers in a uniform manner. It involves the addition of the organic compound from the vapor phase, and the process may be done by either a mutual or a pre-irradiation process, using Co^{60}. Systems that accelerate the rate of graft copolymerization were studied, and it is possible to add significant amounts of several of the monomers without radiation damage to the fiber substrate. The fibrous materials that are relatively unstable toward radiation are the ones that add the vinyl compounds the most readily. These are the cellulosics, cellulose-esters, polyamides, and polypropylene. The addition of the monomer to the fiber substrate apparently takes place through a free-radical mechanism and, as already indicated above, it is possible to irradiate the material first and subsequently obtain grafting by exposure of the irradiated material to the monomer vapor. Attempts were made to determine the life of the free radicals. It was demonstrated that they may continue to exist in some fibers for 15 to 20 hours after irradiation, even at room temperature. Preliminary experimental evidence also suggested that the diffusion time of the monomer to free-radical sites in post-irradiation grafting proceeds at different rates in the different fibers. The modification of cotton by the addition of polyacrylonitrile results in a fiber almost completely resistant to microorganisms. Only 3.5% deposition is required and the material retains the appearance and feel of untreated cotton. The product is superior to that made by the addition of acrylonitrile using the iron-peroxide catalyst system. Polypropylene may be grafted with several different monomers to produce a fiber that is dyeable by commonly-used dyeing procedures. At the present stage of development, however, the wash fastness of the grafted and dyed materials are not good enough for commercial acceptance. The strength of cellulose acetate yarn, as well as the modulus, can be materially increased by the addition of polyacrylonitrile. Other monomers do not behave in this manner. There is some indication that the fiber may be improved with one compound, especially with respect to its behavior in the wet state. (auth)

39368 IMPROVEMENTS IN OR RELATING TO ELECTRICAL POWER SOURCES. (to Telefunken GmbH). British Patent 936,165. Sept. 4, 1963. Priority date Mar. 9, 1960, Germany.

A semiconductor power source, in which at least one p-n junction is irradiated to produce electrical power, is patented. A β source, such as Ni^{63} or Pd^{107}, is placed in or near the blocking layer in the semiconductor. The source should not exceed ~100 kev to prevent damage to the semiconductor crystals. The β rays cause more electrons than normal to be lifted from the valency band into the conductivity band, resulting in an increased charge carrier formation and generating a voltage at the p-n junction. (M.P.G.)

INSTRUMENTS AND INSTRUMENTATION

General and Miscellaneous

Refer also to abstracts 38591, 38592, 38595, 38596, 38597, 38598, 38599, 38602, 38605, 38977, 38978, 38979, 38980, 38981, 38982, 38983, 38987, 38989, 38991, 39810, and 40164.

39369 (AERE-R-3667) A NON-DISPERSIVE X-RAY FLUORESCENCE SPECTROGRAPH. J. T. Campbell, J. Giltrap, and H. I. Shalgosky (United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England). July 1963. 17p.

The construction of a relatively inexpensive non-dispersive x-ray fluorescence spectrograph which has a conventional x ray tube as the source of primary radiation is described. The results of tests of the sensitivity, resolving power, and reproducibility of the instrument are given. (auth)

39370 (ARL-63-147) RESEARCH ON HIGH-TEMPERATURE STRAIN GAGE ELEMENTS. C. B. Jordan (Electro-Optical Systems, Inc., Pasadena, Calif.). June 1963. Contract AF33(657)-8869. 71p.

An attempt was made to find materials for use as strain gages at temperatures above 2000°F (1093°C). Five materials were investigated: silicon carbide, silicon, pyrolytic graphite, rutile, and gallium phosphide. The gage factors of these materials were measured in the temperature range of 25°C (77°F) to 750°C (1382°F). The gage factor of silicon carbide was found to be very small even at room temperature, and none of the other materials appeared to offer any possibility of retaining a useful gage factor at 2000°F. However, several results which may well be of practical value were obtained: the usefulness of silicon as a strain gage was extended to about 650°C (1202°F) by a new contacting process, silicon carbide was found to be a good temperature sensor over a wide range of temperature, and rutile was found to be a good oxygen sensor over a fairly wide range of elevated temperature. (auth)

39371 (AWRE-E-13/63) THE DEVELOPMENT OF A PITOT-STATIC PRESSURE GAUGE FOR OBTAINING DYNAMIC BLAST PRESSURE TRANSIENTS. E. J. Clabburn (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Sept. 1963. 32p.

The development of a small gauge with a stagnation pressure range up to 60 psi and a rise time less than 0.5 ms is reported. The readings of this gauge, plus the hydrostatic (side-on) measurements normally made, give the dynamic pressure. The gauge head consists of a cup fixed to the face of a type MQ18 piezo-electric gauge; it can, however, be easily adapted to fit any suitable transducer. The fixing of dimensions is described together with the characteristics for optimum performance. (auth)

39372 (BNL-6728) ADAPTATION OF A COMMERCIAL COUNTER X-RAY DIFFRACTOMETER FOR INVESTIGATIONS TO 3000°C. Samuel LaPlaca, Gerald Farber, and George Adler (Brookhaven National Lab., Upton, N. Y.). Feb. 6, 1963. Contract AT-30-2-GEN-16. 15p.

A General Electric XRD-5 diffractometer equipped with a scintillation counter, a pulse height discriminator, and a modified version of the Model X-86G high-temperature diffractometer attachment, was modified for x-ray diffraction analysis at temperatures up to 3000°C. These modifications include frame assemblies, viewing port, filament materials, and thermocouples. (D.L.C.)

39373 (BNL-7185) DETAILED DESCRIPTION OF ELECTRONIC MICROSCOPE STAGE MANIPULATOR. E. J. Rogers (Brookhaven National Lab., Upton, N. Y.). July 8, 1963. Contract AT(30-2)-Gen-16. 20p.

A stage manipulator is described which scans the slide automatically. Means are provided for presetting the horizontal and vertical limits of motion, horizontal rate, and vertical step size. The following components of the manipulator are described: electronic control system, horizontal programmer, and vertical programmer. (D.L.C.)

39374 (DESY-A2.102) ZÄHLVERLUST IN ELEKTRONISCHER LOGIK DURCH STATISTIK UND TOTZEIT. (Counting Loss in Electronic Logic Through Statistics and Dead Time). J. Weber (Deutsches Elektronen-Synchrotron, Hamburg). July 1963. 24p.

Counting loss problems arising in the use of electronic equipment in high energy experiments are discussed. Three types of errors are specified: counting loss, false signals and time-jitter. Some statistical relations that lead to special test-methods are presented. The measuring device, that is used to test DESY standard electronics is described. (auth)

39375 (EURAEC-591) HEAT TRANSFER AND STABILITY STUDIES IN BOILING WATER REACTOR. Special Technical Report No. 3 on THE DESIGN OF AN EXPERIMENTAL ACCOUSTICAL SET-UP. (Eindhoven, Netherlands. Technische Hogeschool). Jan. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 032-60-11-RDH. 41p.

An experimental setup is designed for studying the acoustical properties of liquid–vapor bubble mixtures in a boiling loop. The frequency range is 1,000 to 10,000 cps. A block diagram of the setup is presented, and the selection of the components is discussed. The design of the sound wave generator is described. (D.L.C.)

39376 (HW-63552) A LINEAR RISE CALORIMETER FOR MEASURING STORED ENERGY IN GRAPHITE. K. Koyama (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 15, 1960. Contract AT(45-1)-1350. 8p.

A linear-rise calorimeter for stored energy determinations in graphite was constructed to operate up to 1500°C. Adequate instrumentation is provided for a constant temperature rise of 10 degrees per minute. By recording the power input to the sample heater, a spectrum of stored energy as a function of temperature is obtained. Tests with unirradiated graphite show the reproducibility of the power curve to be about ± 5%. Except for the installation of an electronic wattmeter for recording the power, the apparatus is ready for stored energy measurements on cored samples from HAPO reactors. (auth)

39377 (HW-72191) CENTRIFUGAL FLOW ELEMENT TEST. G. L. Erickson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 11, 1962. Contract [AT(45-1)-1350]. 19p.

The six elbow centrifugal flow transducers tested will indicate flow to within ± 7% of the mean flow indication in the forward or reverse direction at temperatures between

50 and 150°F. This could be reduced to ± 3% for the same conditions by following some of the fabrication and testing recommendations. Static pressure variations between 15 and 65 psig had no measurable effect on any of the differential pressure vs. flow relationships. (auth)

39378 (IDO-16878) A MECHANICAL NEUTRON FILTER FOR A CRYSTAL SPECTROMETER. J. R. Smith and H. G. Miller (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). June 14, 1963. Contract AT(10-1)-205. 13p.

A velocity selector of the Dash-Sommers type with straight slits was constructed for use with the MTR crystal spectrometer. The rotor, designed to remove undesirable higher order contaminants from the Bragg beam, is built of magnesium and fiberglas-epoxy laminate to minimize weight and is driven directly by a $\frac{1}{8}$-hp synchronous motor. Vanes of fiberglas laminate are set into 235 slots milled around the periphery of a 4" diameter magnesium core. High strength is attained by winding the assembled rotor with glass filaments impregnated with epoxy resin. Effective helical pitch is obtained by setting the rotor axis at an angle to the Bragg beam. Below 0.25 ev, the rotor gave good suppression, but the transmission was low. (auth)

39379 (NAA-SR-Memo-8902) NOTE ON THE FLAT SPECIMEN SPINNER FOR X-RAY DIFFRACTION. D. J. Klein (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 19, 1963. Contract [AT(11-1)-Gen-8]. 10p.

The commercial flat-specimen spinner is analyzed to determine the principle of its operation as an averaging device. An application of its use in semiquantitative determination of the rocking widths of crystallites of polycrystalline material is suggested. (auth)

39380 (NYO-10555) APPLICATIONS OF ULTRASONIC ENERGY: ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS. Bimonthly Progress Report No. 5, June 1–July 31, 1962. (Aeroprojects, Inc., West Chester, Penna.). Aug. 1962. Contract AT(30-1)-2910. 20p.

A design for an ultrasonic probe to detect the position of the foam-water interface in a boiling water reactor is described. The applicability of the device in the Borax V Reactor has been discussed with personnel at Idaho Falls, and the installation details are being discussed with them. The target date for test is December 1, 1962. An experimental ultrasonic instrument for the determination of liquid levels in fused salt and liquid metal reactors has been constructed and tested on simulant liquids. With a modified version in which interfacial reflection problems were greatly reduced, liquid levels were determined in a semi-continuous fashion. A design for an improved probe is presented. (auth)

39381 (TID-19482) THE DEVELOPMENT OF A HIGH-POWER KLYSTRON AMPLIFIER TUBE. Interim Technical Report, December 12, 1960–June 30, 1961. A. C. Grimm, T. E. Yingst, and A. W. Bachman (Radio Corp. of America. Electron Tube Div., Lancaster, Penna.). Nov. 21, 1961. Includes Appendices: A. UNIFORM FIELD PERMANENT MAGNET FOR THE STANFORD LINEAR ACCELERATOR HIGH-POWER KLYSTRON TUBE. M. J. Schindler. Mar. 27, 1961. B. FEASIBILITY OF SINGLE-FIELD-REVERSAL FOCUSING OF A RELATIVISTIC ELECTRON BEAM. F. Paschke. C. ANALYSIS OF HIGH-POWER MICROWAVE WINDOW PROBLEM. PART I. WINDOW FAILURES IN HIGH POWER STANFORD KLYSTRONS. PART II. POSSIBLE SOLUTIONS. Bayram Vural (Radio Corp. of America. RCA Labs., Princeton, N. J.). D. RCA PROPOSED TENTATIVE OUTLINE FOR THE STANFORD LINEAR ACCELERATOR HIGH-POWER KLYSTRON TUBE. A. C. Crimm and W. E. Harbaugh. Jan. 16, 1961. For Stanford Univ., Calif. W. W. Hansen Labs. of Physics. Contract AT(04-3)-363, Sub-contract S-126. 182p.

Several r-f output window configurations were designed, fabricated, and tested. An effort was made to construct windows such that foreign materials would not contaminate the dielectric surfaces. Techniques were developed for fabricating windows. The feasibility of replacing the electromagnet focusing system with a permanent magnet system was studied. Measurements were made on scale models of uniform field and reversed-field magnets. The theory used in the permanent magnet design calculations, experimental verification of the theory, and the design calculations are reported. Also, the feasibility of single-field-reversal focusing of a relativistic electron beam is analytically demonstrated. The proposed klystron design (including tentative dimensions) is presented, and the facilities constructed to exhaust and test the klystron amplifier tube are described. An analysis of window failures observed in Stanford high-power klystrons, and the conclusions therefrom, are also included. (D.C.W.)

39382 (EURAEC-700) MODIFICATIONS MADE TO THE MAGNETOTHERMODYNAMIC APPARATUS. Special Report No. 17, January 1, 1963 to March 31, 1963. (Societe des Forges et Ateliers du Creusot, Paris). Work Performed under United States–Euratom Joint Research and Development Program. 9p. (A translation)

A spot follower recorder (described) was added to the magnetothermodynamic apparatus for measuring temperatures and detecting magnetic transformations in metals. The operational principles of this sensitive magnetothermodynamic system and the usual thermal system are outlined, and results obtained for 10% Cr martensitic steel by the two methods are compared. (D.C.W.)

39383 NEW MODELS OF THICKNESS GAUGES. Jacques Guizerix. Dechema Monograph., 43: 365-73 (1962). (In German)

Three radioactive thickness gages in which the measurements are not affected by variations of the electronic unit are described. In these gages, which are very different in their operating principles, an absorbing, rotating flap is employed that allows the separation of the radiation of a measuring source from a reference source. (auth)

39384 COLD CATHODE DECADE TUBES AS ADDRESS ELEMENTS & CHANNEL STORES IN MULTICHANNEL ANALYZER SYSTEMS. P. K. Parwardhan and M. G. Phadnis (Atomic Energy Establishment, Trombay, India). Indian J. Pure Appl. Phys., 1: 260-2(July 1963).

The application of dekatron tubes in address logic and channel stores in multichannel analyzer systems is considered, and circuits for dekatron drive developed for this purpose are discussed. The glow dynamics in such circuits is explained on the basis of the new concept of alpha and beta transfers. A brief account of the design and performance (bringing out the effect of certain parameters on overall performance) of an integrated 100-channel analyzer system, which incorporates the new circuits, is also included. (auth)

39385 ADIABATIC MICROCALORIMETRY BY AUTOMATIC COMPENSATION FOR MEASURING RADIOACTIVITY. [PART] II. A. Sanielevici and J. Nagl (Laboratoire de l'Agence Internationale de l'Energie Atomique, Seibers-

dorf, Austria). Intern. J. Appl. Radiation Isotopes, 14: 347-50(Aug. 1963). (In French)

The improvements made to an automatic compensated adiabatic microcalorimeter allowed the sensitivity of the instrument to be increased by a factor of 50. A needle containing about 88×10^{-6} g Ra^{226} could be calibrated with a precision of ±1%. (auth)

39386 APPARATUS FOR MEASUREMENT OF MAGNETIC FIELD INTENSITY. R. L. Fogel'son and N. V. Kotosonov. Izmeritel. Tekhn., No. 6, 41-2(1963).

A magnetometer based on the Hall effect is described. The Hall emf on a $15 \times 5 \times 1$ mm Ge strip with a Hall constant of 1.6×10^4 cm^3/k is measured by the compensation method, with a vibration galvanometer serving as the indicator. The overall measurement range is 1000–30,000 Oe. The measurement error of the device does not exceed 1%, and its sensitivity is said to be high. It works on 50-cycle a-c, is portable, and can be used for measurements in relatively narrow gaps. (OTS)

39387 PHOTOELECTRON MULTIPLIERS WITH TOROIDAL EMITTERS. A. G. Berkovskii, V. G. Gusel'nikov, and F. E. Shapovalov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 932-6(July 1963). (In Russian)

Three types of photomultipliers are discussed. The three differ in cathode diameters, 50, 100, and 150 mm, but utilize the same toroidal multiplier system consisting of 14 amplifier cascades. The construction of these photomultipliers is described. For the 50-mm-diam. cathode type the electrode profiles, the equipotential lines, and the photoelectron trajectories inside the cathode chamber are displayed in a diagram. The focusing systems for the 100- and 150-mm cathode types, which are made up of five electrodes, are much more complex and are not shown. The parameters and characteristics of the photomultipliers are determined by illuminating the photocathode surfaces by means of a heat lamp at a color temperature of 2854°K. The dependence of the anode sensitivity and of the dark current is determined and displayed as a function of the source voltage for all three sizes of cathodes. The time characteristics of the 150-mm photomultiplier and its stability limits are given in tabular form. (TTT)

39388 NEW MINIATURE PHOTOELECTRON MULTIPLIERS. A. G. Berkovskii and T. A. Filimonova. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 937-9(July 1963). (In Russian)

A miniature photomultiplier is described. The external diameter of the photomultiplier is 15 mm, while the cathode diameter is 10 mm. These tubes were designed for use in medicinal dosimetry but can be used in other portable apparatus. The minimal integral sensitivity of the cathodes and anodes is 30 microamperes/$lumen^{-1}$. This sensitivity for the anode was obtained for voltages not greater than 1600 v. The characteristic dependence of the anode sensitivity and of the dark current on the supply voltage was determined and displayed on a graph. Another photomultiplier is being developed with the same dimensions and the same number of cascades (ten) but with a different design system of antimony–cesium emitters. (TTT)

39389 SINGLE-TRANSIT E-TYPE TRAVELLING-WAVE DEVICES. W. M. Nunn, Jr. (Bendix Corp., Detroit). J. Electron. Control (1), 15: 201-27(Sept. 1963).

A small-signal analysis is presented for single-transit E-type traveling-wave devices in which a bunched electron beam follows a circular path and interacts with an azimuthally propagating electromagnetic wave. The ribbon-shaped beam is maintained on the proper trajectory, without the use of focusing magnets, by balancing the electron centrifugal force against a steady radial electric-field force. The present investigation differs from earlier studies in a number of important respects: (1) The solutions apply to electron ribbons having all values of center-of-the-beam radius; (2) the origin of azimuthally directed electromagnetic field components in inhomogeneously loaded coaxial-cylindrical transmission systems is more closely examined; (3) the effect of the radial r-f space-charge field on the interaction process, and its importance relative to the aximuthal field, receives attention; and (4) both unperturbed and slipping-stream motion for ribbon beams undergoing helical motion are treated in order to demonstrate the close relationships existing between electron streams possessing helical and plane circular motion. Numerical solutions are carried out for two limiting situations: One single-transit E-type tube is chosen to have a center-of-the-beam radius of 0.100 in. while another has a beam radius of 11.8 in. These results show that the small-signal solutions of large-radius E-type devices closely resemble those of O-type tubes. The rate-of-change of gain (with spatial angle), which is shown to be an increasing function of the radius of curvature of the beam, is bounded between two definite limits: (1) The gain rate approaches zero as the radius of beam curvature vanishes; (2) the gain rate approaches that of O-type tubes as the radius of beam curvature becomes infinite. For beam radii of 1 in. or more, practical E-type devices possess gain rates closely approaching those of O-type tubes. The practicability of single-transit E-type tubes is contingent upon finding means to substantially improve beam stiffness. (auth)

39390 DETERMINATION OF DEW-POINT BY THE USE OF A RADIOACTIVE α SOURCE. Hisanobu Kobayashi (Inst. of Physical and Chemical Research, Tokyo). Japan. J. Appl. Phys., 2: 592-3(Sept. 1963). (In English)

A new device was made to determine the dew-point from the variation in ionization current due to the absorption of alpha particles by the dews. The construction of the hygrometer is shown. (auth)

39391 ON THE KINEMATICAL THEORY OF DIFFRACTION CONTRAST OF ELECTRON TRANSMISSION MICROSCOPE IMAGES OF PERFECT AND PARTIAL SCREW DISLOCATIONS. R. Gevers (Studiecentrum voor Kernenergie, Mol, Belg.). Phil. Mag. (8), 8: 769-85(May 1963). (BLG-185)

A previously developed kinematical theory for the diffraction contrast of the electron microscope image of a perfect screw dislocation parallel to the surface of the crystal foil was extended theory for a perfect dislocation of mixed type with slip plane parallel to the surface. The theory is applied to a partial screw dislocation parallel to the surface. Numerical calculations were performed for $n = \pm 1/3, \pm 2/3, \pm 4/3, \pm 5/3, \pm 7/3$, and $\pm 8/3$, where n = g.b (g: diffraction vector, b: Burgers vector). It was found that for $|n| = 1/3$ the line contrast is unimportant, probably negligible, that for $|n| = 2/3$ an observable line image superposed on the stacking-fault contrast should be present, and that for larger values of |n| the line contrast becomes much more important than the stacking-fault contrast. (P.C.H.)

39392 ON THE DYNAMICAL THEORY OF ELECTRON TRANSMISSION MICROSCOPE IMAGES OF DISLOCATIONS AND STACKING FAULTS. R. Gevers (SCK-CEN, Mol, Belg.). Phys. Status Solidi, 3: 415-39(1963). (BLG-186). (In English)

An examination was made of the properties of bright- and dark-field electron-microscope diffraction contrast

images of dislocations with glide planes parallel to the crystal surface. In particular, the dependence of the image profiles on the crystal thickness and on the position of the dislocation in the foil was studied. The purely dynamic case, such as the crystal exactly at the reflecting position, was considered. The foil is composed of three partial parallel foils: a central portion, containing the dislocation, sandwiched between two outer portions that have a high degree of perfection. The transmission and diffraction of electrons by each portion is described by a scattering matrix, the matrix for the complete foil being the product of these three matrices. The matrices were obtained by using the system of differential equations for the dynamic case of transmission and diffraction of electrons (with absorption), using the column and two-beam approximations. It is shown that several properties of the contrast images can be derived without detailed solution of the equations, only their structure and the properties of the displacement functions of the dislocation being considered. The properties were found to be in full agreement with both the profiles obtained by numerical integration of the equations for a large number of cases. The amplitudes of the waves transmitted and diffracted by a foil containing a sequence of stacking faults, parallel to the surface of the foil, were also calculated. (auth)

39393 A METHOD FOR MEASURING THE THICKNESS OF THIN BENT FOILS IN TRANSMISSION ELECTRON MICROSCOPY. P. Delavignette and R. W. Vook (Franklin Inst., Philadelphia). Phys. Status Solidi, 3: 648-53(1963). (BLG-178). (In English)

A new method for measuring the thickness of thin monocrystalline foils in the range of 1000 Å is presented. The method is based on the observation of Kossel-Möllenstedt fringes in transmission electron microscopy. It differs from the classical Kossel-Möllenstedt method in electron diffraction by the fact that no divergent beam is needed. However, the foil should be bent and the method is based on the measurement of this radius of curvature. (auth)

39394 SHIFT OF EXTINCTION CONTOURS DUE TO THE PRESENCE OF DISLOCATIONS. R. Siems, P. Delavignette, and S. Amelinckx (SCK-CEN, Mol, Belg.). Phys. Status Solidi, 3: 874-85(1963). (BLG-184). (In English)

The deformation of prisms and elliptical cylinders, resulting from the presence of an arbitrary dislocation line parallel to one of the main axes of the cross-sections is discussed. It is shown that in general the specimen is both bent and twisted. The deformation appears in the electron microscope as a shift of the extinction contours where these cross the dislocations. The sign and magnitude of the shift depend on the magnitude, the sign and the orientation of the Burgers vector with respect to the dislocation line, as well as on the operating diffraction vector and local curvature of the foil. For a particular dislocation in tin disulfide it was possible to verify the theory in detail. (auth)

39395 DOUBLE MAGNETIC SUSPENSION. J. W. Beams (Univ. of Virginia, Charlottesville). Rev. Sci. Instr., 34: 1071-4(Oct. 1963).

A double magnetic suspension is described, in which the lower rotor is magnetically suspended from the upper rotor, which in turn is magnetically suspended. The upper rotor may be made to surround the lower (or inner) rotor. Consequently, the effective magnetic suspension and vacuum chamber surrounding the inner rotor may be made to spin at approximately the same speed as the inner rotor (or within a few rps). This suspension greatly reduces the rotor's deceleration when it is coasting freely. (auth)

39396 DEFLECTING MODE IN CIRCULAR IRIS-LOADED WAVEGUIDES. H. Hahn (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instr., 34: 1094-1100(Oct. 1963).

The theory of the deflecting or hybrid electromagnetic mode in an iris-loaded waveguide is presented. The dispersion diagrams of the two lowest passbands are computed and compared with experimental data. TM_1 and TE_1 modes are not independent solutions of Maxwell's equations if the phase velocity equals the velocity of light. In this case the most general field expressions require the use of hybrid solutions, which are derived from Hertzian vectors with transverse components. The hybrid solutions, in contrast to transverse solutions, are able to give a transverse deflection to synchronous, ultrarelativistic particles. The fields in the slot region and the center region of the iris-loaded waveguide are represented as Fourier series. Matching the four tangential field components results ultimately in an infinite matrix. A vanishing determinant constitutes the relationship between wave number, phase velocity, and geometry. A simple first-order approximation is derived and interpreted. (auth)

39397 NEW TYPE OF POSITIVE ION DETECTOR FOR THE SIMULTANEOUS MEASUREMENT OF TWO BEAMS. N. R. Daly (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Rev. Sci. Instr., 34: 1116-20(Oct. 1963).

A positive ion detector is developed that is capable of simultaneously measuring two ion beams. It is made up basically of two scintillation detectors back to back. Ion beams enter a chamber on either side of a thin dividing partition. They are attracted to two electrodes at 40 kv, where they release secondary electrons. A magnetic field directed along the axis of the incoming positive ion beam deflects the two electron beams so that they strike opposite walls of the ion detector. Two small organic phosphors situated in the walls at the electron impact points produce light signals that are recorded by photomultipliers. Focusing of the electron beams and the efficiency of detection for gas and heavy metal ions are investigated. Measurements of tungsten isotopic ratios show that the stability of the system is such that the precision of measurement is defined almost entirely by the statistics on the number of ions counted. (auth)

39398 NONINTERRUPTING METHOD FOR MEASURING PULSED CHARGED PARTICLE BEAM CURRENTS. W. C. Lineberger and J. W. Hooper (Georgia Inst. of Tech., Atlanta). Rev. Sci. Instr., 34: 1123-5(Oct. 1963).

A noninterrupting method for measuring a charged-particle beam current consisting of a series of periodic pulses is presented. The pulsed beam is allowed to pass through a high permeability toroid on which is wound a multiturn coil. If the distance traveled by a beam particle during one pulsing period is large compared with the toroid dimensions, then the voltage induced in the coil consists of a series of impulses, the time integral of each impulse being proportional to the beam current. Since this voltage is equal to that induced in the coil by a one-turn loop wound on the toroid and carrying a current identical to the beam current, it is possible to vary this current, and employ the multiturn coil as a null indicator to indicate equality of the beam and loop currents. If now a capacitor adjusted to resonate with the multiturn coil is placed across the coil, the sensitivity of the null circuit is increased by a factor equal to the Q of the resonant circuit. Using this resonant magnetometer and a 1000-cps chopping rate, currents of

3×10^{-7} amp peak are measured with an accuracy of $\pm 10^{-8}$ amp. (auth)

39399 BEAM-PROFILE DETECTOR. Julius Solomon and Sypko W. Andreae (Univ. of California, Berkeley). Rev. Sci. Instr., 34: 1126-9(Oct. 1963). (UCRL-10831)

A beam-profile detector that employs a pair of continuously moving scintillation counters as a detector and a pulse-height amplifier (PHA) as a multichannel scaler is described. The number of counts per fixed number of incident particles at every 0.1 in. of travel is recorded in consecutive channels of the analyzer. A total of 7 in. is traversed in 42 sec, after which the profile may immediately be displayed on the cathode-ray-tube readout of the PHA. The device is useful in its present form for accelerators having high beam-repetition rates. Plans for its adaptation for use at pulsed accelerators are also discussed. (auth)

39400 LIQUID HELIUM DEWAR ATTACHMENT FOR AN X-RAY DIFFRACTOMETER. Charles A. Stochl and Selma G. Ullman (Army Electronics Research and Development Lab., Fort Monmouth, N. J.). Rev. Sci. Instr., 34: 1134-8(Oct. 1963).

A double Dewar attachment is designed for use with an x-ray diffractometer. Operating temperatures are the points fixed by the coolant used or by pumping on the inner Dewar, although data can also be taken on a warming cycle. Experiments on Mn_3O_4 at liquid helium temperature give no evidence for a crystal structure change associated with the ferrimagnetic transition at 43°K. (auth)

39401 USE OF LANTHANUM HEXABORIDES AS ION SOURCE IN CATHODE ION SOURCE. Yu. B. Paderno, L. I. Romanyuk, and V. S. Fomenko (Inst. of Physics, Academy of Sciences, Ukrainian SSR and Inst. of Metal Ceramics and Special Alloys, Kiev). Ukr. Fiz. Zh., 8: 707-8(June 1963). (In Ukrainian)

Performance of lanthanum hexaboride as an ion source cathode was studied using 6-mm diameter, 1.5-mm thick compressed LaB_6 powder specimens (68% La, 30.7% B, and 0.11% C). Performance characteristics of thermally purified and treated sources in helium were: $U_a = 200$ v, $I_a = 1.5$ amp, and H = 900e. Discharge streaming density was 5.3 amp/cm^2; ion streaming density in the source reached 0.3 amp/cm^2; the life of the cathode was 30 to 40 hrs. (R.V.J.)

39402 IMAGE AMPLIFIER FOR PARTICLE TRACK PHOTOGRAPHY. Otto Gildemeister and Rudolf Giese (Universität, Bonn). Z. Angew. Phys., 16: 124-30(Aug. 1963). (In German)

An image amplifier for particle track photography is described. The amplification of the light intensity reaches approximately 10^6, the upper limit, and then each individual photoelectron of the input cathode produces an image point in the output image. The image resolution is completely suitable with 100 μm for the luminescent chamber applications. The image diameter of 3 cm is sufficient in many cases, but it can be increased to 6 cm without modification of the construction. Larger image diameters are not possible since the image field in the image formation is limited by the scintillator to the image amplifier of the high-speed objectives. (tr-auth)

39403 LIQUID SODIUM LEVEL MONITOR (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-878)

The liquid-sodium-level monitor is used to monitor the sodium level in the dump and fill tank, and in the surge tank of the Na coolant system of the Los Alamos Molten Plutonium Reactor Experiment (LAMPRE). The power supply, oscillator, amplifiers, discriminators, receiving selsyns, and read out devices for the monitor are located in the reactor control room. The transducers and associated operating mechanisms are located above stainless steel wells which penetrate the dump or surge tanks. Read out is given to the nearest tenth of an in. The dump tank indicator normally operates with its coil in a thimble at an ambient temperature of approximately 300°C. The actuating motor, gear trains, etc., are required to function in the high ambient temperature and high gamma flux existing in the sodium equipment room when the reactor is operating. The surge tank indicator operates with its coil in a thimble immersed in sodium at 480°C to 600°C. The actuating motor, etc., operates in a room with normal conditions. (F.L.S.)

39404 DEVICE FOR RECORDING AND REPRODUCING COUNTS BY A PHOTOGRAPHIC MEMORY. Francois Berger (to Commissariat à l'Energie Atomique). British Patent 933,573. Aug. 8, 1963. Priority date Dec. 1, 1959, France.

A photographic device for recording and reproducing pulse counts is patented. A temporary light is produced from an electrical signal representing the count to be recorded. The recording-reproducing apparatus makes a permanent record of the count with a light-sensitive storage medium, such as film, and reproduces the count from the permanent record by causing electrical signals to be generated to represent the count. To reproduce the counts, the film is projected on to a panel of photoresistors coupled to an electro-mechanical reading unit, which translates the contents of the film into perforations on a tape. (M.P.G.)

39405 IMPROVEMENTS IN OR RELATING TO COOLING MEANS FOR INSTRUMENTS. John Henry Ellinger (to United Kingdom Atomic Energy Authority). British Patent 933,822. Aug. 14, 1963. Filed Dec. 18, 1959.

A cooling system for an instrument used in a high-temperature environment is patented. The system is especially designed for cooling television cameras used with nuclear reactors. An outer casing encloses a hollow-walled porous member, which separates the instrument from its environment. Coolant liquid, which evaporates near the operating temperature of the instrument, is circulated into the hollow-walled member, and vapor is allowed to pass out of the inner and outer regions. The hollow-walled member holds enough coolant liquid to prevent the instrument from becoming overheated if the circulation of coolant is interrrupted for a short time. (M.P.G.)

39406 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR AUTOMATICALLY PERFORMING LABORATORY OPERATIONS. Luc Donald de Seguin des Hons. British Patent 936,861. Sept. 18, 1963. Priority date June 18, 1959, France.

Remote-control apparatus for automatically performing laboratory operations is patented. The apparatus consists of a worktable with superposed working planes, on which displaceable receptacles may be placed and in which stationary devices for performing physical treatments and/or measurements are mounted. A device, which is displaceable vertically, longitudinally, and transversely, is supported by the worktable and carries a set of pipettes. A motor-driven pump and a liquid-level detector control the suction and discharge of liquid through the pipettes. The displaceable device also supports a grip unit for grasping and transferring receptacles. The displaceable device, motor-driven pump, liquid-level detector, and grip

unit may be automatically controlled in a predetermined sequentially timed order. The apparatus may be remotely controlled and may reproduce automatically, as many times as desired, predetermined operation cycles. Various components, including the displaceable device, liquid-level detector, and automatic control mechanisms, are described. (M.P.G.)

Radiation Detection

Refer also to abstracts 38586, 38587, 38588, 38589, 38590, 38593, 38594, 38600, 38601, 38603, 38604, 38607, 38608, 38609, 38610, 38612, 38620, 38995, 39001, and 39005.

39407 (AAEC/M-66) AUTOMATIC SCALER A.A.E.C. TYPE 2A—SERVICE MANUAL. H. J. Fraser and C. Waldron (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). July 1963. 42p.

A manual is presented with operating and maintenance information for the range of counting equipment in use by the A.A.E.C. at Lucas Heights. The equipment is known by the collective designation of Scaler Type 2A. This equipment has been designed in the General Physics Section of the A.A.E.C. General Nucleonics Division. The equipment was built by an Australian manufacturer (Siemens Nucleonics). (auth)

39408 (AD-296353) RADIATION DISCRIMINATORS. AN ANNOTATED BIBLIOGRAPHY. Charlie M. Pierce, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Aug. 1962. 23p. (SB-62-34)

The scope of this search involves instrumentation and circuitry which have been designed to discriminate between the various types of nuclear radiations. A majority of the selected references describe techniques for measuring the intensity of a particular type of radiation in a mixed radiation field. The 57 references are arranged by author. (auth)

39409 (AD-296591) A REVIEW OF DOSIMETRY FIELD. Report No. 4 (Final), September 14, 1961–September 13, 1962. S. I. Taimuty (Stanford Research Inst., Menlo Park, Calif.). Contract DA19-129-qm-1900. 33p.

A review and critical evaluation of the literature on high-level radiation dosimetry published since 1958 are presented. Of the 13 new dosimeters discussed, only three, oxalic acid, polyisobutylene, and Mylar film, seem sufficiently promising to warrant further development. Their current states of development are not sufficiently far advanced, however, to warrant their inclusion in a definitive dosimetry handbook. It is recommended that only the Fricke and ceric sulfate dosimeters be included in the dosimetry handbook. (auth)

39410 (BNL-7186) PRELIMINARY PLANS FOR USE OF HOUGH-POWELL BUBBLE DENSITY MEASUREMENTS. R. C. Strand (Brookhaven National Lab., Upton, N. Y.). Feb. 19, 1963. Contract AT(30-2)-Gen-16. 10p.

The use of bubble density measurements to eliminate obviously wrong mass assignments is described. The process is traced through each of the four computer programs of the Hough-Powell system. (D.C.W.)

39411 (BNL-7187) BUBBLE DENSITY MEASUREMENT WITH THE HOUGH-POWELL DIGITIZER. R. C. Strand (Brookhaven National Lab., Upton, N. Y.). Jan. 1963. Contract AT(30-2)-Gen-16. 21p.

The maximum likelihood method is applied to Hough-Powell Mark I flying spot digitizer bubble density measurements on bubble chamber tracks. The probabilities that a bubble will be recorded or missed are derived. Application of the maximum likelihood solutions obtained to Mark I data and to direct projection table measurements of the same track gave essentially the same results. (D.C.W.)

39412 (CRRD-1161) TECHNIQUE OF DETERMINING FAST NEUTRON DOSE FROM ACTIVATION OF SULFUR TABLETS IN CHALK RIVER FILM BADGES. William G. Cross (Atomic Energy of Canada Ltd., Chalk River, Ont.). Aug. 1963. 11p. (AECL-1811)

The Chalk River film badge holder contains a half-gram sulfur tablet for use in determining unusual overexposures to neutrons of energies above 3 Mev. Tablets are burnt and the P^{32} is counted in a thin-scintillator anti-coincidence counter. The details of the technique and the reproducibility obtained are described. For a 20-minute counting time the probable error in determining a 1-rad dose to the tablet from unmoderated fission neutrons is about 19%. (auth)

39413 (HW-75092) THE USE OF COINCIDENCE COUNTING TECHNIQUES FOR ANALYZING LOW LEVEL PLUTONIUM CONTAMINATION ON FILTERS. M. O. Rankin (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 15, 1962. Contract AT(45-1)-1350. 16p.

An air filter measurement instrument, which uses coincidence counting techniques, was developed to detect 1850 dpm of plutonium in less than two minutes in the presence of 5,000 dpm of natural (radon and thoron) alpha activity on a standard 4 inch × 8 inch filter. The 1850 dpm of plutonium is equivalent to the filter deposition obtained from a continuous air concentration of 2×10^{-12} μc/cc existing for 24 hours with a filter flow rate of 10 cfm; thus, reliable measurement of the collected low level plutonium contamination can be made immediately following acquisition of the filter without waiting for the natural alpha emitters to decay. (auth)

39414 (SAM-TDR-63-25) APPLICATION OF SEMICONDUCTOR RADIATION DETECTORS TO RADIOBIOLOGIC PROBLEMS. George W. Crawford (School of Aerospace Medicine, Brooks AFB, Tex.). Jan. 21, 1963. 37p. (AD-416717)

The experimental characteristics of semiconductor particle detectors have been studied extensively to determine response, resolution, rise time, stability, and irradiation effects. Surface-barrier detectors, diffused p-n junction detectors, and ion-drifted p-i-n detectors have been exposed to many different energies of protons, electrons, photons, and neutrons. The characteristics of the response of each type of detector to each type of ionizing radiation have been determined as a function of geometry and operating conditions. This basic information concerning the detectors is being used to solve radiobiologic problems in the laboratory and in space. The applications include particle identification, energy spectrum measurement, energy absorbed in the Si from the ionizing particle, translation of energy absorbed in Si to energy absorbed in tissue, i.e., dose measurement, and depth dose measurements by embedding detectors in animals. (auth)

39415 (UCRL-6911(Pt.I)) A HELIUM-3 NEUTRON SPECTROMETER WITH EXTENDED ENERGY RANGE. PART I. DESIGN AND DEVELOPMENT OF THE SPECTROMETER. W. Brown and L. Passell (California. Univ.,

Livermore. Lawrence Radiation Lab.). May 1962. Contract W-7405-eng-48. 66p.

The design, fabrication, development, and operation of a helium-3 neutron spectrometer are described. To minimize the wall effect, which is inherent in such a counter, the spectrometer incorporates the wall-less design that essentially eliminates this effect. Krypton under relatively high pressure (66 psia) is introduced along with the helium-3 (16 psia) to afford greater stopping power and higher efficiency. Gas amplification, the gas purification system, the gas handling system for the counter gases, and electron transit time are also considered. (auth)

39416 (UCRL-7427) SCATTERBRAIN: AN AUTOMATED FACILITY FOR CHARGED PARTICLE SCATTERING EXPERIMENTS. J. Benveniste, R. Booth, and A. Mitchell (California. Univ., Livermore. Lawrence Radiation Lab.). July 15, 1963. Contract W-7405-eng-48. 50p.

The 40-inch scattering chamber and associated equipment used with the Livermore 90-inch cyclotron are described, together with techniques used for the accumulation and treatment of data. Remote operation of the several functions of the chamber, such as detector angle drive, target changer, collimator selector, etc., is provided to permit uninterrupted operation of the cyclotron. A series of operations required in the course of an experiment may be programmed and carried out automatically. (auth)

39417 (USNRDL-TR-657) PRIMARY AND SECONDARY GRAIN DENSITIES OF HEAVY IONS IN INSENSITIVE EMULSIONS. E. V. Benton and H. H. Heckman (Naval Radiological Defense Lab., San Francisco). July 6, 1963. 26p. (AD-415083)

The grain densities of stopping C^{12}, O^{16}, and Ne^{20} ions were measured as a function of velocity ($\beta \leq 0.145$) in insensitive Ilford emulsion types K minus 1 and K · 0. The measurements were carried out using photomicrographic techniques. An exponential gap-length distribution is observed for gap lengths greater than 0.25 microns for rates of energy loss up to 2.35 Mev/micron. The composition of the grain density is analyzed in terms of primary and secondary grain densities. It is concluded that the secondary grain density, which is due principally to γ-rays, accounts for about 35 percent of the total grain density observed in these insensitive emulsions. A generalized formula derived from these data expresses the observed grain density as a function of the particle's velocity and charge, and the sensitivity of the emulsion. (auth)

39418 (USNRDL-TR-664) THE RGI-20 RADIAC SYSTEM — A WIDE RANGE BETA-GAMMA INSTRUMENT. II. THE SOLID STATE PULSED GM TUBE LOW RANGE ACCESSORY PROBE. W. F. Joseph (Naval Radiological Defense Lab., San Francisco). Aug. 2, 1963. 30p.

A plug-on low-range accessory, consisting of a main unit and a cable-connected probe, was developed for the RGI-20 radiac system. The solid-state circuit for pulsed GM tube operation is contained in the main unit whose dimensions are approximately $2 \times 2\frac{1}{2} \times 6$ in. The GM tube is mounted in a cable-connected probe with side and end beta window provisions. Ranges covered by the unit are 0–1, 0–10, 0–100, and 0–1000 millirad/hr; temperature affects accuracy by less than ±20 percent from −40 to +50°C. The operating power, rate-computing circuit, and scale-changing meter display are provided by the basic high range (0–1000 rad/hr) RGI-20 module. (auth)

39419 (EURAEC-609) NATURAL URANIUM–0.05% PLUTONIUM FUEL. NEUTRON COUNTING EQUIPMENT FOR CHECKING THE PLUTONIUM CONTENTS OF THE RODS. Special Report No. 5. (France. Commissariat a l'Energie Atomique, Paris). [nd]. Work Performed under United States–Euratom Joint Research and Development Program. 6p. (A translation)

It is shown that, in a natural U–Pu alloy rod, the neutron emission is mainly due to U^{238} and Pu^{240}, and that the Pu may be determined with a low-background counter. A detection system is described which consists of a paraffin cylinder enclosing a cavity into which the fuel rod to be measured is inserted, 24 BF_3 counters immersed in this cylinder, and a cadmium shield. The calibrations of the system are discussed. (D.L.C.)

39420 SEMI-PORTABLE WHOLE-BODY COUNTER FOR CESIUM 137 AND OTHER GAMMA-EMITTING ISOTOPES. Y. Naversten, R. C. McCall, and K. Lidén (Univ. of Lund, Sweden). Acta Radiol. (N. S.), 1: 190-204(June 1963). (In English)

A whole-body counter for determination of body burdens of Cs^{137} and other isotopes is described. The counter, easily assembled and disassembled, has small dimensions and the weight is less than 1500 kg. The background reduction is obtained by lead shielding. Effect on the background of the radioactive environment and of the size of the subject was studied. The measuring geometry, a 5 in. × 4 in. NaI(Tl) crystal in a 42 cm chair geometry, has been calibrated by comparison with a static iron-room counter. The sensitivity is 2.76 cpm/nC ^{137}Cs. Measuring accuracy as a function of body burden and background is analyzed. (auth)

39421 BUBBLE CHAMBER OPTICS. W. T. Welford (Imperial Coll. of Science and Tech., London). Appl. Optics, 2: 981-96(Oct. 1963).

Developments in optics and optical systems for use with bubble chambers and in measuring bubble chamber film are reviewed. (auth)

39422 THE TRIGGER CIRCUIT FOR THE 80-IN. BUBBLE CHAMBER LIGHT SOURCE. S. S. Yamamoto and W. P. Sims (Brookhaven National Lab., Upton, N. Y.). Appl. Optics, 2: 997-8(Oct. 1963). (BNL-6881)

A circuit was designed to trigger a high-power flashtube at one per second repetition rate. It increased the life of the tube by a factor of ~100 from its rated life. (auth)

39423 OPTICAL AND MECHANICAL PROPERTIES OF BUBBLE CHAMBER WINDOWS. F. O. Reitmayer and E. W. Deeg (Jenaer Glaswerk Schott & Gen., Mainz). Appl. Optics, 2: 999-1002(Oct. 1963).

In producing large glass blanks for bubble chamber windows and other applications, the thickness and, therefore, size and weight can be materially reduced by increasing the strength characteristics through tempering. The resulting adverse optical effects are discussed, and quantitative measurements of these are given to ascertain whether or not they are tolerable. (auth)

39424 ELECTRONIC FLASH ILLUMINATION OF A LARGE WILSON CLOUD CHAMBER. Harold E. Edgerton (Massachusetts Inst. of Tech., Cambridge). Appl. Optics, 2: 1013-15(Oct. 1963).

Electronic flash tubes may be used to illuminate cloud chambers in order to freeze particles in motion and obtain sharp, clear photographs without blurring the image. Introductory theory of flash tubes is given, and the illumination of 120 × 150 × 60 cm cloud by four 132-cm flash tubes is described. A total energy of 58,800 W-sec is used. (auth)

39425 THE ILLUMINATION OF THE CERN 2-METER HYDROGEN BUBBLE CHAMBER. F. Fruengel (Humburg-Rissen, Stilldorfer Landstrausse, Ger.), H. Koehler, and H. P. Reinhard. Appl. Optics, 2: 1017-24(Oct. 1963).

A general description of the optics of the CERN 2-m hydrogen bubble chamber is given. The chamber is illuminated by three demountable flashtubes with the help of a condensing lens system. The requirements for the light sources and the properties of the prototype are discussed, which combine high intensity (up to 2500 J) with short flash duration (200 μsec), small size of the emitting plasma (15-mm diam) and long life (more than 40,000 discharges at 1000 J). The condenser consists of three units, each with two plano-convex lenses, one of them having an aspherical surface. Theoretical values of the residual aberrations as well as experimental results are given. A short description of the windows and the problem of their antireflection coating is added. (auth)

39426 BUBBLE CHAMBER WINDOWS. W. T. Welford (Imperial Coll. of Science and Tech., London). Appl. Optics, 2: 1037-41(Oct. 1963).

Methods of specification and testing of large windows for bubble chambers are described. (auth)

39427 A DOSIMETER OF IONIZING RADIATION BASED ON MEASURING THE THERMOLUMINESCENCE OF AN ALUMINUM PHOSPHATE GLASS (AN IKC DOSIMETER). I. A. Bochvar, A. A. Vasil'eva, I. B. Keirim-Markus, I. I. Prosina, Z. M. Syritskaya, and V. V. Yakubik. At. Energ. (USSR), 15: 48-52(July 1963). (In Russian)

The following glasses were used to convert ionizing radiation to stored light energy, which is emitted on heating the glass and can be measured by a photomultiplying tube: 5^{0-26} – $MgO \cdot P_2O_5 - Al_2O_3 \cdot 3P_2O_5$; 34^{0-3} – $SrO \cdot P_2O_5 - Al_2O_3 \cdot 3P_2C_5$; 2^{0-3} – $Li_2O \cdot P_2O_5 - Al_2O_3 \cdot 3P_2O_5$; and 58^{0-2} – $SrO \cdot P_2O_5 - SiO_2 \cdot P_2O_5 - 2(Al_2O_3 \cdot 3P_2O_5)$. The glass was activated with 0.1 wt. % MnO_2. A dose from 0.02 r to 1×10^6 r can be determined on a tablet $7 \times 30 \times 30$ mm polished on one side. The light yield from the glass is 2 to 5% and does not depend on the dose rate of Co^{60} γ rays up to 25 r/sec, or of 500-Mev protons up to 400 r/sec. A dose can be measured after a month or longer even at a temperature of 150°C. The glass dosimeter is not affected by daylight exposure, but should be protected from prolonged exposure. The glass dosimeter can be used to determine mixed proton-gamma radiation. The lithium glasses can be used to measure thermal neutron dose but are insensitive to fast neutrons. Measurements on the 5^{0-26} and 34^{0-3} glasses were repeated 50 times and showed no change in the light emission characteristics. A 0.6 mm Sn + 0.5 mm Al filter can be used to compensate for the variation in γ-ray energy from 40 kev and higher. (TTT)

39428 PIP: A PHOTO-INTERPRETIVE PROGRAM FOR THE ANALYSIS OF SPARK-CHAMBER DATA. Harry Rudloe (Bolt Beranek and Newman, Inc., Cambridge, Mass.), Martin Deutsch, and Thomas Marill. Commun. ACM (Assoc. Computing Machinery), 6: 332-5(June 1963). (TID-18120)

An operating computer program that processes photographically recorded data is described. The input to the program consists of spark chamber photographs on which tracks of high-energy particles are recorded. The program automatically scans, measures, and performs the preliminary interpretation of these photographs. In continuous operation a processing rate of 5,000 photographic frames per hour is achieved. (auth)

39429 CONTROL EQUIPMENT USED IN THE LABORATORIES OR WORKS TREATING RADIOACTIVE SUBSTANCES. Jean Morichère. Dechema Monograph., 43: 353-63(1962). (In German)

Equipment for the determination of the thorium and uranium contents in minerals by means of their characteristic radiation is presented. A description of the apparatus used for monitoring aerosols for contamination in the laboratories that process these minerals is also given. (auth)

39430 A DETECTOR FOR HIGH NEUTRON FLUX MEASUREMENTS. G. Casarelli (SORIN, Vercelli, Italy). Energia Nucl. (Milan), 10: 431-4(Aug. 1963). (In English)

A detector for high neutron flux measurement is described. The working principle is based on the direct collection of electric charges emitted from a short-life beta source activated by the neutron flux itself. Experimental results obtained with a $Rh^{103}(n,\gamma)Rh^{104}$ detector (half life 42 sec) are reported. The main features of the detector are: no need of power supply for charge collection; very little gamma sensitivity (the ratio of the signals from a gamma dose rate of 10^8 rad/h and from a thermal neutron flux of 10^{12} n cm^{-2} sec^{-1} is about 1%; the possibility of reading the electric signal with a galvanometer; and the possibility of miniaturization. (auth)

39431 DETERMINATION OF APERTURES FOR A BETA-SPECTROMETER WITH DOUBLE AND TWO-FOLD $\pi\sqrt{2}$ FOCUSING. A. V. Zolotavin. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 914-22(July 1963). (In Russian)

Aperture calculations are made by using an electronic computer for a beta spectrometer, which utilizes a two-fold $\pi\sqrt{2}$ focusing in a magnetic field which itself is characterized by twin focusing. This type of spectrometer possesses good resolution and transmission qualities and is simple to construct. The following results are presented in tabular form: coordinates for entrance slits to be used with resolutions of 0.8, 0.4, and 0.2%; and coordinates for shutters to be used with resolutions of 0.8, 0.4, and 0.22% and for seven different symmetry planes in the magnetic field corresponding to the angles 42° 3′, 74° 3′, 106°, 169° 6′, 212°, 297°, and 339°. (TTT)

39432 CONCERNING THE QUESTION OF THE SIMULTANEOUS MEASUREMENT OF THE ENERGY AND ANGLE OF EMISSION FOR PARTICLES IN A SEMICONDUCTOR DETECTOR. G. E. Kocharov and Yu. N. Starbunov (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 940-1(July 1963). (In Russian)

It is shown that with the aid of a single semiconductor detector it is possible to measure, simultaneously, the energy and the angle of emission of a nuclear particle. This possibility is based on the fact that the amplitude of the registered pulse depends on the angle of emission. As an illustration, the pulse shapes are shown for a 5-Mev alpha particle entering a p-type 100 ohm-cm silicon detector. It is pointed out that the angle dependence of the pulse amplitude disappears when the emission angle is greater than arc $\cos(d/R_0)$, where d is the sensitive depth of the counter and R_0 is the range of the particle in the detector material. The fast time resolution possibilities of these detectors makes them valuable for use in correlation experiments. (TTT)

39433 AMPLITUDE-TIME DISCRIMINATION OF GAMMA-RAY BACKGROUND IN A FAST NEUTRON SCINTILLATION SPECTROMETER. G. G. Doroshenko, I. V. Filyushkin, and V. A. Fedorov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 949-52(July 1963). (In Russian)

An apparatus, which utilizes amplitude-time discrimination to separate out gamma background from fast neutrons in a scintillation spectrometer, is described. The elec-

tronics portion of the resolution system is shown in a block diagram. It consists of a resolving circuit, a resolution channel, a time-delay channel, and a coincidence circuit. The operation of the resolution system is illustrated by an oscillograph display which shows the separation of neutron and gamma pulses resulting from a Po–Be source. The resolution and scintillation spectrometer thresholds of the system were found to be 20 and 80 kev, respectively. The resolution apparatus was found to operate well as long as the integral load did not exceed 4000 pulses/sec. (TTT)

39434 TRANSISTORIZED AMPLIFIER FOR ALPHA SPECTROSCOPY WITH THE AID OF p-n COUNTERS. I. M. Beskrovnyi. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 956-60(July 1963). (In Russian)

The characteristics of a transistorized amplifier are described. The amplifier is designed for use in alpha spectroscopy employing p–n type counters. Circuit diagrams are shown for an impedance transformer and the amplifier itself. The amplifier circuit has a high-frequency corrector added to it. The Po^{210} alphas (E_α = 5.301 Mev) are displayed taken with a single-channel analyzer and the transistorized amplifier, and σ for the polonium alpha peak was found to be 0.78%. A signal from a generator is also shown, and the noise of the system was found to be 26 kev, which corresponds to a noise charge of 1.2×10^{-15} coulombs. Since the capacity of the amplifier is small (less than 1.5 pf) the noise level of the system can be decreased by using a p–n counter with a small capacity. The noise of the amplifier itself is found to be less than 17.7-kev which corresponds to a noise charge of 8.1×10^{-16} coulombs. (TTT)

39435 POINT ANODE PROPORTIONAL COUNTERS. E. Mathieson and P. W. Sanford (Univ. of Leicester, Eng.). J. Sci. Instr., 40: 446-9(Sept. 1963).

An experimental investigation of point anode proportional counters is described. The point to end-window distance is found to be an important parameter in determining counter performance. A resolution of 21% at 6 kev can be achieved with an end window $\frac{1}{8}$ in. in diameter in a counter of internal dimensions only 1 in. × $1\frac{3}{8}$ in. Data concerning gas multiplication, efficiency, and sensitive volume are given. A possible operating mechanism is discussed qualitatively. (auth)

39436 LARGE AREA SCINTILLATION DETECTORS USED FOR COSMIC RAY DETECTION. Ivan Lehraus (Inst. of Physics, Czechoslovak Academy of Sciences, Prague). Jaderna Energie, 9: 252-7(1963). (In Czech.)

A review is given of the characteristic properties of large-area scintillation detectors that may be applied in the cosmic ray field. Individual factors important for the design of these detectors are discussed, and their influence on resulting properties evaluated. (auth)

39437 THE ORIGIN OF ERRORS IN SAMPLE PREPARATION FOR ABSOLUTE CALIBRATION OF BETA-EMITTING ISOTOPE SOLUTIONS WITH A 4π-COUNTER. Josef Klumpar and Miroslava Majerova (Inst. of Radiological Dosimetry, Czechoslovak Academy of Sciences). Jaderna Energie, 9: 258-64(1963). (In Czech.)

The origin of errors in the individual phases of the preparation of samples for the absolute calibration of solutions used as beta sources was investigated. The weight of ions adsorbed on the glass surface, treated with methylsiloxane and polyethylene, was determined experimentally, and the portion of the beta radiation which was absorbed in adjacent crystals was determined. The optimum concentration of the carrier material found by this method may be regarded as a justification of the currently used concentrations. As a byproduct of this experiment, it was found that the explosion of dissolved air bubbles caused great losses during the sublimation of frozen drops in a vacuum. (auth)

39438 ORGANIC SCINTILLATORS FROM JENA. W. Luedke, F. Rudolph, and K. Sumi (VEB Carl Zeiss, Jena, Ger.). Kernenergie, 6: 413-19(Aug. 1963). (In German)

Organic scintillators are discussed and the most important questions in the technology of their preparation are considered. The high enhancement by conical shaping is described and illustrated by a series of measurements. (tr-auth)

39439 SINGLE PHOTON COINCIDENCE METHOD FOR THE ABSOLUTE MEASURE OF THE EFFICIENCY OF A 1216 Å DETECTOR. F. Cristofori, P. Fenici, G. E. Frigerio, N. Molho, and P. G. Sona (Università, Milan and Laboratori CISE, Milan). Phys. Letters, 6: 171-2(Sept. 1, 1963). (In English)

The absolute efficiency of a windowless magnetic photomultiplier (Bendix 306) enclosed in a vacuum system as a 1216-Å photon detector was measured. The n = 3 level of H atoms was excited by electron impact. The 6562-Å photon emitted in decay to the n = 2 level was detected by an RCA 7265, and the 1216 Å photon emitted in subsequent decay to the n = 1 level was detected with the Bendix 306. The ratio of the number of coincident detections to the number of 6562-Å detections gave the efficiency as $(2.09 \pm 0.15) \times 10^{-3}$. (D.C.W.)

39440 INTEGRAL DISCHARGE CAPACITOR FOR SPARK CHAMBERS. Alvin Kanofsky (Univ. of Pennsylvania, Philadelphia). Rev. Sci. Instr., 34: 1156-7(Oct. 1963).

A spark chamber is described that consists of modules of the form Al sheet–Lucite slab–Al sheet–Lucite slab–Al sheet. The modules are separated by spacers of the form Mylar sheet–Al sheet–Mylar sheet. The plastic thicknesses are chosen such that the capacitance between the inner and outer Al sheets of the module is appreciably smaller than the capacitance between the Al sheet in the spacer and the outer Al sheet of the module. The discharge capacitor for the spark chamber can thus be included integrally within the body of the chamber. The application of this technique to large, nonmodular spark chambers is described. (T.F.H.)

39441 MEASUREMENTS OF BREMSSTRAHLUNG BEAM EMISSION ENERGY BY MEANS OF STANDARD IONIZATION CHAMBER. A. P. Komar, S. P. Kruglov, and I. V. Lopatin (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 33: 949-53(Aug. 1963). (In Russian)

Descriptions are given of a standard ionization chamber for calibrating maximum bremsstrahlung energy spectra. The ionization current was measured with an order of error to 0.1% using a charge volume collected at a given time or with lesser accuracy using any commercial d-c amplifier. (R.V.J.)

39442 FOUR π SLIDE CHAMBER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-259)

The chamber is a redesign of the Borkowski 4π Chamber Q-1277. The sample to be counted is inserted, without opening the counter, on a thin film between the two counting chambers. The chamber may be used for any short-range particle. (F.L.S.)

39443 NEUTRON DOSIMETER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-257)

The instrument is designed to determine the radiation

dose by examining the pulse spectrum produced by radiation in a proportional counter. It consists of a proton recoil proportional counter as the source of the pulses, followed by an Al amplifier, two scalers, a pulse sorter, and a regulated power supply. The pulse sorter consists of a low impedance driver and seven discriminator channels. The sorter differs from the conventional differential types in that all discriminators with bias settings less than the pulse amplitudes pass the pulse. Any number of channels up to fifteen (depending on the pulse amplitude) may view the pulse. The discriminators are connected into successive stages of binary scaling units in such a way that the total number of counts recorded is proportional to the height of the initial pulse. (F.L.S.)

39444 DOUBLE CRYSTAL X-RAY SPECTROMETER (Engineering Materials). (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). (CAPE-1033)

The double-diffracting x-ray spectrometer is used to study the crystallographic features of irradiated materials. This apparatus has three components; a sample holder, a target tube assembly, and a horizontal x-ray-tube positioning mechanism. The remotely controlled sample holder is used to position and rotate radioactive samples. The target tube assembly is used to adjust the position of a curved Al crystal which is placed in the second diffracting position in such a way that it focuses the diffracted x rays into the detector. The horizontal x-ray-tube positioning mechanism is used to support and align the x-ray tube as it rotates on a conventional goniometer. Sufficient lead shielding is used between the sample and the detector to absorb the radiation emanating from the sample in order that such radiation will not influence the detector. No serious loss in diffracted x-ray intensities results from the double crystal arrangement. (F.L.S.)

39445 NEUTRON MONITOR, MODEL 5 (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-984)

The portable instrument is used to make quick, accurate, dose-rate measurements of neutrons with energies from thermal to 7.0 Mev. Dose rates are reported in terms of rems. The instrument responds to thermal neutron energies within ±4% and to fast neutron energies within ±15%. Information obtained with this instrument is ordinarily more accurate than that obtained with the thermal and fast neutron monitoring instruments usually used. Where the scattering of intermediate energy neutrons contributes significantly to the total dose, this instrument detects and evaluates the dose rate with reasonable accuracy and with no assumptions or calculations required. The detector is a lithium iodide crystal 4 mm in dia. and 4 mm thick. The crystal is more than 80% "black" for thermal neutrons. The crystal is coupled to a photomultiplier tube by a light pipe wrapped in aluminum foil to limit light loss. The light pipe containing the lithium iodide crystal is inserted into a 10 in. polyethylene sphere which is calibrated with either thermal or fast neutron fluxes. The output of the photomultiplier tube is fed through a standard preamplifier and amplifier. (F.L.S.)

39446 FAST NEUTRON POLYETHYLENE-LINED PROPORTIONAL COUNTER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-260)

The counter is used to measure very high neutron doses. It is sensitive and has a small volume. The counter tube is a brass cylinder $^{7}/_{16}$ in. OD and $1^{13}/_{16}$ in. long. The extension shell is $15^{1}/_{4}$ in. long and also is of brass. (F.L.S.)

39447 COUNTING STATISTICS OF NUCLEAR PARTICLES. V. I. Goldanskii, A. V. Kutsenko, and M. I. Podgoretskii. Translated from Russian. Delhi, Hindustan Publishing Corporation (India), 1962. 495p.

Counting statistics of nuclear particles based on discrete binomial and Poisson distributions are discussed. The Gaussian distribution is mentioned as a special case. The derivation of the Poisson law is presented and some of its properties and applications are discussed. Problems of radioactive decay, statistics of recordings by particle counters with dead time, and statistical problems related to the operation of scaling circuits and the counting of coincidences are also examined. (C.E.S.)

39448 IONIZATION CHAMBER CIRCUIT FOR THE MEASUREMENT OF DOSAGE OR DOSAGE RATE OF RADIOACTIVE RADIATION. Ernst Alfred Frommhold (to VEB Vakutronik). German Patent 1,149,829. June 6, 1963. Filed Feb. 27, 1960.

An ionization chamber circuit is described which can be switched from dosage to dosage rate measurement. In this circuit the insulated electrode of the ionization chamber is connected to the plate of the electrometer tube known in the art as the inverted operation of the electrometer tube, and the other electrode of the ionization chamber is either switched to the positive pole of a direct current power supply when measuring the dosage rate or switched to the negative pole of the power supply when measuring the dosage. A common meter for both measurements is provided which gives an indication of the current flowing to the grid of the tube. (NPO)

ISOTOPE SEPARATION

39449 ISOTOPE ELECTROMIGRATION IN ION EXCHANGERS. I. ENRICHMENT OF LITHIUM ISOTOPES BY ELECTROMIGRATION IN A CATION EXCHANGE MEMBRANE. Hidetake Kakihana and Makoto Okamoto (Tokyo Inst. of Tech.). Nippon Kagaku Zasshi, 84: 402-4 (1963). (In Japanese)

A cation exchange membrane was used as a medium of electromigration for the separation of lithium isotopes. After spotting lithium hydroxide on the cation exchange membrane in NH_4-form, lithium ion was electromigrated for 30 hr under about 3 v/cm. The amounts of lithium in each fraction of the band were determined by a colorimetric method with thorin and their isotopic ratios (Li^7/Li^6) were determined with a mass-spectrometer Atlas CH-4. It was observed that isotopic ratios were changed from 12.30 to 9.34 at the front part of lithium ions band and to 13.10 at the tail. Considering the average velocities of electromigration of the isotopes (v_6 and v_7), the ratio of difference ($v_6 - v_7$) to v_6 was estimated as 0.008. (auth)

39450 IMPROVEMENTS IN DEVICES FOR THE SEPARATION OF FLUIDS BY DIFFUSION THROUGH A POROUS WALL OR WALLS. Jean-Henri Bertin, Benjamin Salmon, and Lucien Guillaume (to Commissariat à l'Énergie Atomique). British Patent 936,421. Sept. 11, 1963. Priority date Feb. 15, 1960, France

A diffusion cell for the separation of isotopes by gaseous diffusion through a porous barrier is patented. The cell is particularly designed for the separation of U isotopes by diffusion of gaseous UF_6. The gaseous mixture is circulated near porous walls from the cell inlet to the cell outlet. Deflecting members in the central region of the cell along the longitudinal axis of the cell create transverse flow components in the gases. A rectilinear path directly connecting the cell inlet and outlet is provided for the gases along the porous walls. The deflecting members may be helically wound wires, discs, bars, or plates perpendicular to the direction of flow of the gases. (M.P.G.)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 38584, 38585, 38586, 38601, 38603, 38604, 38606, 38612, 39447, and 39452.

39451 (BNL-6829) A DIRICHLET PROBLEM FOR AN EQUATION OF MIXED TYPE WITH A DISCONTINUOUS COEFFICIENT. J. R. Cannon (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT-30-2-GEN-16. 13p.

The solutions for a Dirichlet problem for an equation of the type $K(y)u_{xx} + u_{yy} = 0$, where $yK(y) > 0$ and $y \neq 0$, are considered. Existence and uniqueness criteria are established. (D.C.W.)

39452 (BNL-7215) CONCEPTS IN THE STATISTICAL ANALYSIS OF SPECTRA. Charles E. Porter (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 11p. (CONF-218-2)

From Symposium on Statistical Properties of Atomic and Nuclear Spectra, Stony Brook, N. Y., May 1963.

Some aspects of the statistical analysis of spectra, particularly those for quantum systems, are briefly discussed and demonstrated. (D.C.W.)

39453 (TID-19413) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. ILLIAC II SYSTEM PROGRAMMING AND OPERATION. PART III. CIRCUIT RESEARCH PROGRAM. PART IV. IBM 7094-1401 SYSTEM. PART V. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). July 1963. Contract AT(11-1)-415. 58p.

Developments in the high-speed computer program and in ILLIAC II system programming and operation are reported. A device was constructed that gave a 50% modulation of light by using voltage pulses to alter the index of refraction on nitrobenzene. A relation between the backward coupler and the distributed transformer terminated with one or more pairs of tunnel diodes was developed for the distributed system. Methods of rapid multiplication were investigated. The effects of out-diffusion in the manufacturing process were examined in avalanche breakdown research. Discriminator circuits developed for a statistical analyzer are described as well as the circuitry devised to provide the discriminators with the proper voltages. Two routines were prepared for the 7094-1401 system, and 70 problem specifications (described) were submitted for the IBM-7090. Three instructional problem specifications submitted are also described, and IBM-1401 and IBM-7094 operation and performance are summarized. (D.C.W.)

39454 THE NUMERICAL SOLUTION OF LAPLACE'S EQUATION. P. P. Starling (National Inst. for Research in Nuclear Science, Chilton, Berks, Eng.). Brit. J. Appl. Phys., 14: 603-4(Sept. 1963).

A formula is given for estimating the optimum convergence rate of the finite difference solution of Laplace's equation in cylindrical coordinates. (auth)

39455 KINETIC INTEGRAL SOLUTIONS OF THE BOLTZMANN EQUATION. Crawford MacCallum (Sandia Corp., Albuquerque, N. Mex.). Phys. Rev., 132: 930-1 (Oct. 15, 1963). (TID-18704)

A kinetic picture is presented from which follow the time-dependent Boltzmann equation in the relaxation-time approximation and an exact solution in the form of a kinetic integral. As a special case of the latter, one obtains Chambers' integral solution of the time-independent equation. Confusion in the literature regarding solutions of the exact versus linearized equations is clarified. (auth)

39456 ASYMPTOTIC THEORY OF THE BOLTZMANN EQUATION. [PART] II. Harold Grad (New York Univ., New York). p.26-59 of "3rd International Rarefied Gas Dynamics Symposium. Vol. I." New York, Academic Press, 1963.

In a previous paper, the exact mathematical relationship of the formal Chapman-Enskog expansion to actual solutions of the Boltzmann equation was described. The expansion is proved to be asymptotic (with respect to the mean free path as a small parameter) to quite general solutions of the initial value problem, provided that the correct initial values are imposed in the Chapman-Enskog formulation. Some properties of the Boltzmann equation are derived, which are needed for this asymptotic theory but which also have their own intrinsic interest. Bounds and information regarding the spectrum of the collision operator are obtained as well as an existence theorem for the linearized Boltzmann equation. (auth)

39457 SOME UNCONVENTIONAL MATHEMATICAL PROBLEMS IN MAGNETOHYDRODYNAMICS. C. K. Chu (New York Univ., New York). 19p. (CONF-190-1)

From American Physical Society 1962 Summer Meeting, Evanston, Ill., June 1962.

Several problems arising in the theory of steady, inviscid, infinitely-conducting, compressible magnetohydrodynamics are considered. The problems may be considered as direct generalizations of similar problems in ordinary gas dynamics. In each case, the gas dynamical problem is well-known and fully understood, and the results are generally regarded as intuitively evident; in each case, the corresponding magnetohydrodynamic problem involves additional nonobvious mathematical finesse, and the results reveal certain interesting and unexpected physical phenomena, which are by no means intuitively evident until the solution is obtained The three problems described have their gas dynamic counterparts in three regimes of flow: subsonic, transonic, and supersonic flow. (R.E.U.)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

Refer also to abstract 40341.

39458 (AD-296345) BERYLLIUM. A SURVEY OF THE LITERATURE, JANUARY–MARCH 1962. An Annotated Bibliography. Jack B. Goldmann, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Oct. 1962. 123p.

This annotated bibliography covers 264 publications released during the first quarter of 1962. Citations are arranged alphabetically by author under broad subject headings of Alloys; Analysis; Applications; Compounds; Corrosion; Fabrication Techniques; Joining; Mineralogy; Oxides; Powder Metallurgy and Casting; Processing; Properties; and Miscellaneous. References to the use of beryllium in fuels, nuclear reactor applications, effects of radiation, and Cu–Be alloys are omitted. (auth)

39459 (AD-296351) METAL BORIDES, CARBIDES AND NITRIDES, AND COMPLEMENTARY REFRACTORIES: AN ANNOTATED BIBLIOGRAPHY. Report No. 3-80-62-21. Jack B. Goldmann (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Oct. 1962. 86p. (SB-62-32)

References (202) on metal borides, carbides, nitrides, and complementary refractories that are related to the field of aerospace materials are given to books, reports, patents, and U. S. and foreign journals published from January 1961 through May 1962. Separate author and subject indexes are included. (P.C.H.)

39460 (MRC-386) IRON SINGLE CRYSTAL PREPARATION. Final Report, April 2, 1962–April 1, 1963. G. Abowitz, E. Hughes, and P. Barton (Materials Research Corp., Orangeburg, N. Y.). May 10, 1963. Contract AT(30-1)-2980. 33p.

The purification of iron by electron beam float zone refining was investigated. Results indicate that Johnson Matthey Spectrographic Iron appears to be the best starting material, and 3-pass refining at 5 in./hr has yielded material with a total interstitial content (C, N, and O) of approximately 11 ppm. In addition to chemical analysis, the ratio of the resistance at room temperature to that at 4.2°K was determined and values between 200 and 300 were consistently obtained. This is a further indication of the purity of the iron being produced. The conditions for the growth of high purity iron single crystals by the strain anneal technique were optimized and single crystals up to $2\frac{1}{2}$ in. long and from 0.090 to 0.108 in. in diameter were grown with a 70% yield success. (auth)

39461 (NAA-SR-Memo-8347) VAULT LINER COATING INVESTIGATION. BUILDING 056-SNAP 8—FLIGHT PROTOTYPE TEST FACILITY—SANTA SUSANA. W. S. Netter (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 10, 1963. Contract [AT(11-1)-Gen-8]. 32p.

Based upon a literature search, coatings were chosen for test. Coating contractors were asked to apply their coatings on 2EC or 6061 aluminum samples supplied by Atomics International. The coated samples were irradiated along with uncoated aluminum. The infrared absorption of coated samples was determined prior to irradiation. The infrared absorption after irradiation was determined only on coatings that had a sufficiently high rate of decay. It was found that a sodium silicate coating prepared by the Bechtel Corporation was the most satisfactory coating tested and will meet the requirements of the Building 056 vault liner. However, the abrasion resistance (adhesion) of this coating is marginal and studies should be conducted to improve this quality. Flame-sprayed ten percent titanium dioxide–90% alumina also appeared satisfactory in all respects except that some samples had a decay time longer than 30 days. Two black epoxies appeared to be promising but they tended to be impregnated by mercury. It is recommended that the sodium silicate paints be developed further to improve their adhesive and cohesive strength. Titanium dioxide is an excellent filler in paints. A determination should be made of the impurities which decrease the decay rate of flame-spray coatings containing titanium oxide. The epoxies appear to be on the threshold of utility and further work should be done to increase their reliability as atomic-irradiation-resistant coatings. (auth)

39462 (NAA-SR-8403) ROLE OF BORON IN GROWTH OF BERYLLIA SINGLE CRYSTALS. S. B. Austerman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 30, 1963. Contract AT-11-1-GEN-8. 15p.

The influence of boron in the growth of BeO single crystals from lithium molybdate flux was studied. The concentration of $LiBO_2$ was varied from 0.05 to 5 wt % of the MoO_3 flux component. Throughout this entire range, the crystal habit and characteristics of growth in the negative and positive polar directions were considerably modified. The supersaturation level required for crystal nucleation and significant growth rate was markedly reduced. The boron was found to enter the crystal lattice, without detectably altering lattice constants, and, in some cases, to introduce a distinctive reduction in crystal symmetry. (auth)

39463 (NMI-2119) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report to United States Atomic Energy Commission for the Month of July 1963. (Nuclear Metals, Inc., West Concord, Mass.). Sept. 12, 1963. Contract AT(30-1)-2784. 19p.

Methods of fabricating tungsten and rhenium–tungsten alloy tubing by extrusion and drawing are discussed. Deformation behavior of zone-refined beryllium single crystals is studied by compressing along the c-axis. The development of copper–uranium alloys by SLIS techniques is described along the properties of the alloys. (N.W.R.)

39464 (NP-13122) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. Mary F. Banks, comp. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Aug. 1963. Contract AF 33(616)-7747. 91p.

A listing in abstracted form is presented on 158 selected documents and journal articles on subjects within the technical scope of DMIC. The list is arranged according to high-strength alloys, light metals, nonmetallics, refractory metals, and miscellaneous. Author and subject indexes are included. (D.L.C.)

39465 (SCNC-328(Del.)) TIN–ALUMINUM PROTECTIVE COATINGS FOR COLUMBIUM ALLOYS. L. Sama and J. Grubessich (Sylvania Electric Products Inc. Sylcor Div., Bayside, N. Y.). Nov. 1961. Contract AT-30-1-GEN-366. 27p.

Pure Nb, Nb–1 Zr, and Nb–5 Mo–2 Ti–2 Zr alloys were coated by hot dipping in several Sn–Al-base baths. Oxidation tests were performed at 1100, 1400, and 1800°F for up to several thousand hours. All of the materials could be protected for a minimum of 500 hours. An alternate coating technique employing a duplex cold spray-hot vacuum diffusion process appeared to give somewhat superior results. (auth)

39466 (AEC-tr-6021) RHENIUM. J. Sagoschen. Translated for Oak Ridge National Lab., Tenn., from Metall., 16: 1193-5(1962). 15p.

A review is presented of the origin, production, properties, and applications of rhenium. (D.L.C.)

39467 (EURAEC-429) PLUTONIUM RECYCLING. Quarterly Report No. 6, July 1 to September 30, 1962 (France. Commissariat a l'Energie Atomique, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 037-60-12 RDF. 8p. (A translation)

The preparation and properties of plutonium dioxide fuels, and the fabrication and properties of plutonium-uranium alloy fuel elements are discussed. (N.W.R.)

39468 (EURAEC-520) EXAMINATION OF ZIRCONIUM HYDRIDE IN ZIRCALOY 2 AND ZrNb ALLOYS. Quarterly Report No. 5, October 1–December 31, 1962. (Siemens-Schuckertwerke A. G., Erlangen, Germany). Work Performed under United States–Euratom Joint Research and Development Program. 44p. (A translation)

The mechanical properties, corrosion, and hydrogen absorption of Zircaloy-2 and niobium–zirconium alloys are given. The properties are studied with respect to hydrogen content. The absorption of hydrogen from superheated steam at 500°C and 1 atm is shown. A metallographic examination is made of hydride precipitation in corroded samples of Zircaloy-2 treated with hydrogen. (N.W.R.)

39469 (EURAEC-602) STEEL MATERIAL FOR REACTOR VESSELS. INVESTIGATION OF THE RESISTANCE TO BRITTLE FRACTURE OF HEAVY PLATES JOINED BY WELDING. Special Report No. 3. Activity Report to December 31, 1962. Weisz, Prudhomme, Le Bret, and Brionne (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Cadarache). Work Performed under United States–Euratom Joint Research and Development Program. Contract 038-60-12RDF. 12p. (A translation)

Static flexion tests were carried out on Mn–Mo steel plates assembled by manual cornice welding and having 5 parallel brittle seams deposited onto a welded zone. Fracture occurred at –2°C, indicating a transition temperature not greatly different from that of the base metal (–7°C). Tests were also conducted on C–Mn steel plates with 5 and 25 brittle seams, to study the effect of the "total length" of the brittle deposits on the transition temperature. The transition temperature was found to increase by 20°C between 5 and 25 seams. (D.L.C.)

39470 (EURAEC-619) EXAMINATION OF ZIRCONIUM HYDRIDE IN ZIRCALOY-2, AND ZrNb ALLOYS. Quarterly Report No. 6, January 1, 1963 to March 31, 1963. (Siemens-Schuckertwerke A. G., Erlangen, Germany). Work Performed under United States–Euratom Joint Research and Development Program. Contract 024-61-10 RDA. 38p. (A translation)

The program of experiments was continued with the carrying out and evaluation of corrosion experiments in superheated steam at 500°C and 1 atmosphere pressure on Zry-2, ZrNb 1, and ZrNb 2.5 in a β heated state. The results were made known and discussed in connection with the analytically determined hydrogen contents. With the termination of the experiments on the β heated alloys, the program of corrosion of Zry-2, ZrNb 1, and ZrNb 2.5 in superheated steam at 1 atmosphere is concluded. The heat treated states examined of the alloys are compared with one another from the point of view of corrosion behavior and hydrogen absorption, in a summary evaluation of the corrosion results. For the samples charged with hydrogen from the gas phase (Zry-2, ZrNb 1, and ZrNb 2.5, vacuum-smelted, β heated) the values determined in the tensile tests were interpreted graphically. The precipitation forms of the zirconium hydride in corroded and charged samples were examined metallographically. The results of the tests with Zry-2 in the as delivered condition (cold-worked) and Zry-2 (sic) which were reproduced in the last Quarterly Report were completed by the findings of the experiments on ZrNb 1 and ZrNb 2.5 in the as delivered condition (cold-worked) and Zry-2 in the β heated state. (auth)

39471 (EURAEC-648) PRODUCTION OF SWAGED FUEL ELEMENTS. Quarterly Report No. 11, January 1 to March 31, 1963. P. Himmelstein, W. Hoppe, H. Kroll, B. Liebmann, and O. Neumann (Nuklear-Chemie und-Metallurgie G.m.b.H., Wolfgang bei Hanau am Main, Germany). Work Performed under United States–Euratom Joint Research and Development Program. Contract 062-61-7-RDD. 47p. (A translation)

Uranium dioxide was melted by direct current flow, and tests were made both with vertical and horizontal disposition of the electrodes. The lumps of melted UO_2 obtained are compact and weigh up to 4 kg. In the UO_2 melting tests performed in a hydrogen melting furnace, the molten UO_2 retained a small amount of tungsten (<50 ppm), even when reflux powder was used. A new welding chamber under inert gas was constructed, with which faultless welds can be obtained on swaged steel and zirconium tubes. For the swaging tests, UO_2 was precompacted by vibration, to 75, 80, and 83.5% of theoretical density. The highest cold-swaging densities were comprised between 90 and 92% of theoretical density, after a reduction of cross-section comprised between 21 and 26%. At the outset, the steel tubes measured 18 × 0.4 or 18 × 0.3 mm. The firmness of UO_2 can now be increased to such an extent that the material can be ground to microslides, thus affording a means for detecting the coarseness of the UO_2 grains and the condition of the inside wall of the tube after deformation. According to the first results, inner surface defects exceeding 10% of the wall thickness only occur after cross-section reductions of 40%. Apart from measurements of density, density variations, and tube dimensions, information is also given on the results of some Xe diffusion measurements. (auth)

39472 (EURAEC-668) EXAMINATION OF THE EFFECT OF NEUTRON IRRADIATION ON THE PROPERTIES OF THE ALLOY ZrNb3Sn1. Quarterly Report No. 3, January 1–March 31, 1963. (Metallgesellschaft A. G., Frankfurt am Main). Work Performed under United States–Euratom Joint Research and Development Program. Contract 092-62-7 RDD. 23p. (A translation)

Tests are to be carried out in a swimming-pool reactor to determine the effect produced by neutron bombardment at various irradiation levels on mechanical properties and corrosion behavior. During the third quarter, the fabrication of the samples, sample mountings, and blank element for the irradiation test was completed. After determination

of the spatial and energy distribution of the neutron flux, irradiation of the samples was started. The irradiated sample element had received 472.6 Mwh by the end of the third quarter. The testing of the mechanical and chemical corrosion properties of the nonirradiated control samples was continued, the results obtained concurring well with those gained in the previous tests. (auth)

39473 (EURAEC-705) CORRELATION BETWEEN THE METHODS OF PRECIPITATING PLUTONIUM SALTS AND SINTERING THEIR OXIDES. Special Report No. S10. (Societe Belge pour l'Industrie Nucleaire, Brussels and Brussels. Centre d'Etude de l'Energie Nucleaire). [1963]. Contract 027-60-7 RDB. 46p. (CONF-193-3). (A translation)

From 8th Nuclear Congress, Rome, June 1963.

Plutonium salts were precipitated as peroxides, oxalates, and hydroxides, using various experimental conditions (temperature, pH, etc.). The precipitate was then calcined under air at temperature on the 200 to 1000°C range. For each precipitation route and calcination temperature, the Pu content, the tap density, the specific area, the crystal and grain sizes, and their form were checked. Experiments on the sintering behavior of those powders were conducted at various temperatures (1000 to 1600°C), under wet H and high-purity Al. Correlations are drawn between the sintering density and the experimental parameters: properties of the powder, pelletizing pressure, and sintering temperature and atmosphere. (auth)

39474 (FTD-TT-62-1678) AVIATION PHYSICAL METALLURGY. S. M. Vinarov. Translation of "Aviatsionnoe Metallovedenie Uchebnoe Posobie" (A publication of the State Publishing House for Defense, Moscow, 1962). 96p.

A book is presented on the physical nature of metals and alloys, their heat treatment, and their behavior during operation in physical designs. Particular attention is devoted to the properties of the materials at high temperatures. The alloys considered are light alloys, iron-based alloys (steels), nickel-based alloys, and refractory alloys. (D.L.C.)

39475 TECHNOLOGICAL ASPECTS OF ALUMINUM ALLOYS IN NUCLEAR ENGINEERING. S. S. Smith and R. Dickson. Nucl. Eng., 8: 367-71(Oct. 1963).

A review is presented of certain aspects of the use of Al alloys in nuclear engineering. These aspects include corrosion, dispersions in AEREAL alloys, precipitation in Al–Mg alloys, fuel cans, fabrication, jointing techniques, etc. The future prospects of aluminum are discussed briefly. (D.L.C.)

39476 SILICON HEAVILY DOPED BY ENERGETIC CESIUM IONS. J. O. McCaldin and A. E. Widmer (North American Aviation Science Center, Canoga Park, Calif.). Phys. Chem. Solids, 24: 1073-80(Sept. 1963). (In English)

Cesium ions of a few kilovolts energy were driven in (110) direction into p-type silicon held at 500°C. This treatment introduced donor centers at concentrations $> 4 \times 10^{19}$ cm^3, even though the solubility of cesium is estimated to be $\lesssim 10^{15}$/cm^3. This supersaturation was observed to relax very slowly at 500°C, though the damage introduced by the bombardment annealed. Consequently, the diffusivity D_{Cs} at 500°C is estimated to be $\lesssim 10^{-15}$ cm^2/sec (compared to $D_{Li} = 10^{-7}$ cm^2/sec). Field-effect transistors were fabricated with Cs-bombarded material constituting the "channel." A field-effect carrier mobility about half that of a comparable, phosphorus-diffused channel was observed. A minimum sheet donor concentration of 2×10^{13}/cm^2 was indicated in the field-effect measurements, with the likelihood that the actual concentration is appreciably larger. Tracer measurements showed the cesium sheet concentration to be $\sim 6.8 \times 10^{14}$/cm^2. Various evidence suggests that the concentration profile for the donor centers consists of a layer of relatively slowly changing concentration near the surface followed by an exponentially decreasing "tail" at greater depths. (auth)

39477 IMPORTANCE OF PURITY IN DEVELOPMENT OF CERAMICS. C. T. Lynch and J. J. Krochmal. RTD Technol. Briefs, 1: 1-6(Oct. 1963).

A general survey is presented of the problems of purity and phase control in refractory inorganic nonmetallic materials. A number of specific examples of the effects of impurities on the properties of the materials are given. The research programs being carried out on obtaining high-purity well-characterized materials are described. Improved analytical methods are discussed briefly. It is concluded that knowledge and characterization of a given material can be more important than purity level. (D.L.C.)

39478 IMPROVEMENTS IN OR RELATING TO THE TREATMENT OF SURFACES. (to Heberlein & Co., AG). British Patent 932,430. July 24, 1963. Priority date June 18, 1959, Switzerland.

A process for imparting stain or water repellent properties to the surface of a polymeric material is patented. The material may be a textile fabric, yarn, fiber, paper, plastic film, or leather. An organic olefinically unsaturated polyfluoro compound, which is an ether or an ester, is grafted to the surface of the material under the influence of ionizing radiation, which may be x rays or γ rays. Certain materials, such as cellulosic material, may be exposed first to ionizing radiation, then treated with a solution or emulsion of an organic polyfluoro compound, heated to a temperature between 50 and 80°C, washed, and dried. Other material, such as paper or leather, should be treated first with the polyfluoro compound, then exposed to ionizing radiation, heated, washed, and dried. The irradiation may take place in the presence or absence of atmospheric oxygen, in vacuo, or in the presence of an inert gas. Suitable organic polyfluoro compounds are listed. (M.P.G.)

39479 THERMOSETTING CARBONACEOUS CEMENT. (to Great Lakes Carbon Corp.). British Patent 936,514. Sept. 11, 1963. Priority date June 1, 1960, United States.

A thermosetting carbonaceous cement, which is particularly useful for joining carbon and graphite articles, is patented. The cement consists of from 40 to 75 parts by weight of an alkaline-catalyzed phenol-formaldehyde liquid resole-type resin and from 25 to 60 parts by weight of a solid carbonaceous, filler such as coke, graphite, or carbon black. The cement has a good shelf life and a minimum of filler-binder separation if a thickening agent such as the Na salt of carboxymethyl hydroxyethyl cellulose is added. If it is necessary to apply the cement at low temperatures, the addition of a monomeric glycol and/or glycerine will decrease the viscosity of the cement. Carbon bodies are bonded by pressing the bodies together with the cement at their interface, curing the cement below carbonization temperature, and then heating the joint in a nonoxidizing atmosphere to a temperature above 700°C until the cement has carbonized. (M.P.G.)

Corrosion

Refer also to abstract 40393.

39480 (BLG-174) ETUDE DE QUELQUES FACTEURS INFLUENÇANT LA CORROSION DE L'ALUMINIUM DANS UN REACTEUR NUCLEAIRE. (Study of Some Factors In-

fluencing the Corrosion of Aluminum in a Nuclear Reactor). P. Renders and G. Spaepen (Brussels. Centre d'Étude de l'Énergie Nucléaire). June 1963. 22p. (CONF-195-1)

From Third Congress of the European Federation on Corrosion, Brussels, June 1963.

Factors governing the corrosion of aluminum and its effects on the operation of nuclear reactors are discussed. The results of electrochemical, static, and dynamic tests are given, each experiment being designed to study one or several of the factors: surface preparation; temperature effects from 40 to 150°C; hydrogen pick-up in the metal; impurities in the cooling water; thermal cycling; thermal flux; and neutron and gamma irradiation of additives to the water during storage of spent fuel elements. (auth)

39481 (EURAEC-611) IN-PILE CORROSION OF NUCLEAR MATERIALS. Quarterly Report No. 4, January 1 and March 31, 1963. (Brussels. Centre d'Etudes de l'Energie Nucléaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 084-62-3 RDB. 17p. (R-2218)

The modifications, loading, and testing of the new loop system are described briefly. In the old loop system, two series of potentiodynamic measurements were made on Pt electrodes in various electrolyte solutions and on the pitting of stainless steel 316L in chloride solutions. Large changes with irradiation were observed in the potential curves of Pt electrodes. The critical concentration level for pitting of stainless steel 316L increased from 2×10^{-2} to 5×10^{-2} M KCl when irradiated. A new single pulse generator is described. (D.L.C.)

39482 (EURAEC-616) MICROGRAVIMETRIC INVESTIGATION INTO THE MECHANISMS OF CORROSION OF REACTOR MATERIALS IN THE PRESENCE OF NUCLEAR RADIATION. Quarterly Report No. 5, January 1–March 31, 1963. (Battelle Institut e. V., Frankfurt am Main). Work Performed under United States–Euratom Joint Research and Development Program. Contract 071-61-12RDD. 33p.

The $Sr^{90}-Y^{90}$ β source was installed in the microgravimetric corrosion apparatus. The dose rate absorbed by the samples is of the order of 10^5 rad/hr. In the microgravimetric corrosion experiments with Fe, Zr, and stainless steel in 650mm O_2, 13mm H_2O, or 650mm $O_2 + H_2O$ for durations up to 120 hr at temperatures up to 260°C, no radiation effect was observed. As to the kinetics of corrosion, results are in agreement with earlier experience: at elevated temperatures, the time dependence of weight gains approximates after some hours the equation $\Delta g = A \cdot t^n$ (Δg = weight gain, $\mu g/cm^2$; A = constant, t = time, hours) with exponents n between 0.5 and 0.33. With Armco iron in oxygen at 25°C, no weight gain was observed within 12 hours. As shown by the electron micrographs, the oxide layer formed in air on pure iron at 200°C (average thickness 500 Å) is covered in part by semispherical rugosities having diameters of the order of 500 Å. After reduction with hydrogen at 250°C, the oxide layer formed on iron at 260°C, leaves a spongy layer (roughness factor 5.4). Upon heating in hydrogen at 350°C this layer sinters (roughness factor 2.7). Surface rugosities that are resolvable by the electron microscope do not account for the observed magnitude of the roughness factors. (auth)

39483 (EURAEC-660) STUDY OF VARIOUS METAL OXIDATION PROBLEMS AND APPLICATION OF IMPEDANCE MEASUREMENT METHODS TO THE STUDY OF RESISTANCE TO CORROSION IN AN AQUEOUS MEDIUM. Quarterly Report No. 4, January 1, 1963 to April 30, 1963. (Brussels. Universite). Work Performed under United States–Euratom Joint Research and Development Program. Contract 081-62-5 RDB. 35p.

The results obtained during the last quarter of this year are mostly concerned with the formation of oxide crystals of a particular type (whiskers, plaquettes) on various metals and alloys which have been studied for that purpose. These crystal forms constitute an important part of the products of a reaction obtained under quite ordinary conditions. The relations to the metal, as well as the physical causes of these growths, are imperfectly known. A study of these effects on the Au–Cu–O_2 system has made it possible to show once more the importance of the phenomenon of oxide dissolution in the metal. Ultimately, in the case of nickel, it was possible to bring out various germination/nucleation fields in which the behavior of oxide is very similar to that of the cuprous oxide which can be formed on copper. The adsorbant which had been used formerly (active coal and silica gel) was replaced by a platinized platinum gauze in the cell which was already described. The study of the variation of differential capacity in time, during the formation of platinum and gold oxides, was continued, under different tensions, in a perchloric and sulphuric medium. The capacity increase which was observed for comparatively short periods can only be observed under these conditions. For longer oxidation periods, the differential capacity decreases when anodization is prolonged. The investigations of the coulometric technic for measuring the quantity of oxide formation were continued and a nitrogen bubble electrode was developed which permits measurement with a fair reproductibility of polarographic currents on the platinum electrode. (auth)

39484 (EURAEC-688) IMPERFECTIONS IN METALS. II. CORROSION AND OXIDATION. Quarterly Report No. 2, January 1 and March 31, 1963. (Brussels. Centre d'Etudes pour les Applications de l'Energie Nucleaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 082-62-7-RDB. 22p.

A review is given of the rather complex oxidation behavior of niobium. The present state of knowledge and doubt about the influence of dislocations on oxidation, corrosion, and etch pit formation is described. Different treatments for annealing the rolled niobium foils were investigated in order to avoid contamination. Electropolishing conditions were improved, to obtain more reproducible and smoother polishing. Observation of Nb foils annealed at 1500°C in a vacuum of 10^{-5} Torr revealed numerous needle-like precipitates that seemed to be quite tightly embedded in the metal matrix. A mechanism is proposed for explaining the observed fringe contrast at the precipitates. Former stages of formation were detected by annealing the foils at lower temperature. The precipitates interact rather strongly with dislocations and prismatic punching at these precipitates was frequently observed. Finally, experimental conditions were investigated in order to oxidize transparent foils in the very initial stage. (auth)

39485 (EURAEC-738) MICROGRAVIMETRIC INVESTIGATION INTO THE MECHANISMS OF CORROSION OF REACTOR MATERIALS IN THE PRESENCE OF NUCLEAR RADIATION. Quarterly Report No. 6, April 1–June 30, 1963. (Battelle Institut e. V., Frankfurt am Main). Work Performed under United States–Euratom Joint Research and Development Program. Contract 071-61-12RDD. 11p.

In the corrosion experiments carried out so far, no effect of the radiation of the 30-Curie $Sr^{90}-Y^{90}$ β source on

the corrosion kinetics of Fe, Zr, and stainless steel was observed. Therefore, the active parts of the source are being arranged in such a way that the dose rate will be increased by a factor of about 10. With this arrangement, exploratory gravimetric experiments will be carried out with the aim of ascertaining the presence or the absence of radiation effects on corrosion with the higher β dose rate. The experimental set-up for these experiments is under construction. Attempts were made on the determination by the Kelvin method of the porosity of an oxide film formed on iron at 200°C. The presence of many narrow pores was ascertained; it was impossible so far, however, to determine the exact diameter and the pore volume. (auth)

39486 (EURAEC-747) IMPERFECTIONS IN METALS. II. CORROSION AND OXIDATION. Quarterly Report No. 3, April 1 and June 30, 1963. (Brussels. Centre d'Etude de l'Energie Nucleaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 082-62-7 RDB. 22p.

The carbon extraction replica technique was used in order to separate the acicular precipitates, observed in niobium specimens after annealing treatment, from the metal matrix. A description is given of this technique. For dissolving the metal, a solution on the basis of bromine, tartaric acid, and alcohol is used. Numerous small precipitates allowed ring diffraction patterns to be made. Selected area diffraction on several larger precipitates revealed monocrystalline diffraction patterns. The precipitates are found to exist in two different modifications. The structure data of none of the niobium compounds reported in the literature can be identified with the observed interplanar distances. The first results of a study on the initial oxidation stage of niobium are shown. Electron microscopy in transmission is used in the investigation on oxidized transparent niobium foils. Nucleation and growth of platelet structures were observed on specimens oxidized at 600°C and a pressure of 10^{-4} torr. As in the stage under investigation there is no diffraction evidence for definite suboxide nor oxide phases, it is assumed that the observed phenomena occur during or directly after the dissolution of oxygen in the metal matrix. Observations on the form, growth, dependence of grain orientation, and foil thickness are illustrated. (auth)

39487 (GEAP-4310) GENERAL AND LOCALIZED CORROSION STUDIES OF TYPE 300 SERIES AUSTENITIC STAINLESS STEELS IN SIMULATED SUPERHEAT REACTOR ENVIRONMENT. W. L. Pearl, G. G. Gaul, and G. P. Wozadlo (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 1963. Contract AT(04-3)-189. 56p.

The following conclusions are based on the out-of-pile general corrosion and localized attack studies completed to-date on several 300 series stainless steels: 1. In a sodium chloride-cycle test that produces a type failure that can occur in a superheat reactor system, Types 347 and vacuum-melted 304 SS have failed while vacuum-melted 310 SS was acceptable. 2. An improved chloride cycle test utilizing ferric chloride as the additive was developed that produces an intergranular type failure similar to that experienced in the fuel cladding failures in the SADE and ESADE facilities. Types 304 and 316 SS have failed in the test. 3. Present methods of ultrasonic testing will find through cracks but are not completely dependable for assessing lesser degrees of intergranular attack. 4. It is hypothesized that a definite interplay exists between chemical attack and stress. The application of stress will orient intergranular attack preferentially in a direction perpendicular to the stress. (auth)

39488 (LAMS-2948) COMPATIBILITY EVALUATION OF MATERIALS WITH CESIUM. Edward S. Keddy (Los Alamos Scientific Lab., N. Mex.). Aug. 1963. Contract W-7405-eng-36. 28p.

The compatibility of materials in liquid cesium is described for a temperature range from room temperature to 500°C and in cesium vapor for a temperature range of 300 to 1000°C. Compatibility data are presented for ceramics, metals, and alloys. Gold and silver and alloys containing these metals were found to be the least resistive to attack throughout the temperature range when in contact with cesium liquid or vapor. The refractory metals, high purity aluminas, magnesia, beryllia, and many more metals and alloys were resistant to cesium attack within the temperature range. (auth)

39489 (NP-13116) CAVITATION DAMAGE IN LIQUID METALS. Quarterly Progress Report 235-5, April 2, 1963–July 2, 1963. H. S. Preiser and A. Thiruven Adam (Hydronautics, Inc., Laurel, Md.). Sept. 1, 1963. Contract NASr 105. 16p.

Maximum effort was applied to design a new research test facility for cavitation damage testing of refractory materials in liquid sodium at high temperature. A feasibility study was completed which will incorporate a sodium loop into a vacuum dry box. The new dry box will include an integral elevating mechanism to house the magnetostriction device and allow in place calibration. Detailed purchase specifications are in preparation and invitations to bid will be circulated to qualified manufacturers in the early part of the next report period. A systematic series of experiments were performed to determine how small variations of geometric parameters associated with the magnetostriction apparatus would affect cavitation damage rate with a view toward standardizing test conditions for all future experiments. The results indicate that beaker size, liquid depth, and depth of immersion have no effect on cavitation damage rate within the limits tested. Specimen size appears to affect the damage rate considerably and therefore a fixed size is necessary. This size is based primarily on convenience of specimen preparation and ease of examination. It was established that a rimmed specimen is not required to achieve reproducibility of damage in the steady zone. A flat faced specimen is more desirable since it has equal reproducibility to the rimmed type, is not subject to localized rim damage, and is more convenient and less expensive to machine and make visual observations. (auth)

39490 (ORNL-3474) CORROSION OF STAINLESS STEEL IN ACIDIC NITRATE WASTE SOLUTIONS FROM PROCESSING STAINLESS STEEL REACTOR FUELS. D. N. Hess, L. Rice, B. Willis, E. S. Snavely, and W. E. Clark (Oak Ridge National Lab., Tenn.). Oct. 16, 1963. Contract W-7405-eng-26. 31p.

Stainless steel tanks appear to be useful for long-term containment of acid wastes from the reprocessing of stainless steel fuel elements provided that the temperature of the container is kept $\leq$ 50°C and that tanks are constructed so as not to expose grain ends to the solution. Chloride ions up to about 0.02 M and fluoride up to about 0.04 M produced no accelerating effect on the corrosion. Certain organic compounds, for example, glycerol, acted as corrosion inhibitors, as did nitrite. Ferric iron in high concentrations was responsible for a grain-boundary attack that increased in rate with increase in temperature and with increase in free acid concentration. Catastrophic end-

grain attack was observed under the most aggressive conditions. In the usual case, true intergranular attack did not develop even after exposure times of 7000 hr. The presence of Cr(III) appeared to accelerate the attack, but only when Fe(III) was also present. Polarization studies indicated that neither anodic nor cathodic protection would be markedly helpful. Appreciable concentrations of Cr(VI) were shown to be absent from the solution at temperatures as high as 80°C. Radiolysis of these solutions is expected to produce corrosion inhibitors (e.g., NO, NO_2, H_2O_2) rather than accelerators. (auth)

39491 (EURAEC-704) STUDIES OF STEEL CORROSION IN HIGH TEMPERATURE WATER AND STEAM. Quarterly Report No. 3, January 1 to March 31, 1963. (Brussels. Societe d'Etudes, de Recherches et d'Applications pour l'Industrie). Apr. 24, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 089-62-7 RDB. 111p. (A translation)

The influence of the surface state on steel corrosion in high temperature steam and water is studied. The autoclave tests were continued for stainless steel grade 304 and undertaken for Creusot 1.2 MD07 boilerplate steel. Regarding the stainless steel, complete results for the tests in water at 300°C and partial results for the tests in steam at 400°C–200 kg/cm^2 are presented. The evaluation of the corrosion by ponderal variations involves the reduction of the adhering oxides by hydrogen at 800°C. Tests in water at 300°C reveal the favorable character of the Jacquet bath electrolytically polished state. Corrosion is lowered by a factor of about 3 compared with the rough or fine machined or mechanically polished with 600 paper under water states. The advantages that are acquired by the electrolytically polished state cannot be appraised by autoclave tests, as the corrosion rate tends to cancel itself out after a period of time which depends on the surface state. It was revealed that 6 weeks was suitable for classifying the various surface states. In steam at 400°C–200 kg/cm^2, it is observed that the electrolytically polished state is a disadvantage. The latter conclusion does not appear after 2 weeks, the largest amount of corrosion with the electrolytically polished state is shown after 6 weeks. Both in water at 300°C and steam at 400°C–200 kg/cm^2, the behavior of the AISI 304 stainless steel samples in the milled, ground, and mechanically polished with 600 paper states is observed as being very similar. The microscopic examinations on cross-sections of oxidized samples confirm the conclusions which were given on the basis of the ponderal variations. The perfecting of the apparatus necessary for determining the amount of corrosion by measuring the diffused hydrogen is finished. A model of the capsules suitable for the needs of the study was made. A test has enabled the operational conditions to be verified and has made it possible to determine the hydrogen concentrations likely to be encountered in argon. Preparation of a corrosion loop for dynamic tests is being continued. (auth)

39492 (EURAEC-726) STUDY OF A FEW METAL OXIDATION PROBLEMS AND APPLICATION OF IMPEDANCE MEASUREMENT METHODS TO THE STUDY OF CORROSION RESISTANCE IN WATER. Quarterly Report No. 5, May 1 to June 30, 1963. (Brussels. Universite). Work Performed under United States–Euratom Joint Research and Development Program. Contract 081-62-5 RDB. 25p. (A translation)

In most of the metal (or alloy)/oxide lattices studied, the formation of whiskers of oxide was observed (MnO on Mn, MnO on Cu–Mn, CuO on Cu, CuO on Au–Cu, NiO on Cu–Ni, Cu_2I_2 on Cu). The real reason why this particular form of oxide develops is not clear. A study was made of the oxide formation in a fairly simple case (CuO on Cu) by methods and under conditions such as are regularly used for the study of solid-gas reactions. The results obtained generally confirm those obtained to date. Study was begun of the nucleation and the growth of NiO crystals formed by Ni oxidation and of Cu_2I_2 formed on Cu, after the area in which they exist had been determined. (auth)

39493 (EURAEC-757) STUDIES OF STEEL CORROSION IN HIGH TEMPERATURE WATER AND STEAM. Quarterly Report No. 4, April 1 to June 30, 1963. (Brussels. Societe d'Etudes, de Recherches et d'Applications pour l'Industrie). Work Performed under United States–Euratom Joint Research and Development Program. Contract 089-92-7 RDB. 104p. (A translation)

Corrosion studies were made on the influence of the surface states on steel corrosion in high temperature water and steam. Standard corrosion tests were also made in an autoclave and measurement of corrosion by the diffusion of the hydrogen formed during metal oxidation is reported. Static tests in autoclaves on stainless steel type AISI 304 were completed by the results of tests in the steam phase at 400°C–200 kg/cm^2. Evaluation of the corrosion was made by ponderal variations after testing and hydrogen reduction of the adhering oxides at 800°C. It was verified that, as a general rule, irrespective of the surface state, the in-autoclave corrosion rate of 18/8 stainless steel, both in the aqueous phase at 300°C and the steam phase at 400°C–200 kg/cm^2, becomes virtually nil after a uniform test duration of six weeks. Contrary to what was observed for 18/8 stainless steel, it was found that the influence of the surface state, in the case of the boiler-plate steel, is similar in water at 300°C and in steam at 400°C–200 kg/cm^2. The electrolytically polished surface reacts favorably to both kinds of tests. The corrosion rate is lowered by a factor of 2 compared with the 600 polished and ground states. The milled state is different from the other mechanically treated states in that there is a 20% increase in the corrosion rate. Hydrogen diffusion measurement corrosion tests give, in the case of stainless steel and for the various surface states, relative corrosion values that correspond to those determined by the in-autoclave static tests. However, in absolute values, the quantities of metal corroded, with this method and for the same test duration, were twice as high as in the autoclave tests. (P.C.H.)

39494 THE CORROSIVENESS OF SOLUTIONS USED IN THE DISSOLUTION OF FUEL ELEMENTS WITH RESPECT TO VARIOUS MATERIALS OF CONSTRUCTION. M. M. Kurtepov and E. N. Mirolyubov. At. Energ. (USSR), 15: 37-48(July 1963). (In Russian)

The rate of corrosion of a metal depends on the electrochemical potential of the solution which is determined by the nature of the oxidation-reduction reactions in the system. The corrosion of 18-8 stainless steel in boiling HNO_3 solutions (8 to 14 M) is due to the break-down of the passive oxide film and dissolution of a higher oxide film which is soluble. The dissolution process is cathodically controlled. The corrosion rate increases sharply in weak HNO_3 during contact with an electronegative element (contact with platinum in boiling 12 N HNO_3 increases the corrosion rate of 18-8 stainless steel by a factor of 50). Monel metal is resistant to corrosion by HF solutions. The vapor-phase corrosion rate of Monel metal above a HF solution is an order of magnitude higher than the corrosion rate of Monel below the surface of a HF solution. The corrosion of Monel

metal takes place by oxygen depolarization and is cathodically controlled. Corrosion of Monel metal is by intergranular penetration. The addition of small amounts of fluorides to HNO_3 solutions increases the corrosion rate of stainless steel due to the dissolution of the passivating film by HF. The addition of Al^{3+} or zirconium decreases the corrosion of stainless steel, because Al^{3+} and zirconium form strong complexes and thus remove free HF from the HNO_3 solution. The corrosion rate of a stainless steel containing 23% Cr and 27% Ni in boiling 4 to 6 M H_2SO_4 can be reduced by providing cathodic protection or by adding 0.2 g/l of Fe^{3+} ion as a protective oxidizing agent. (TTT)

39495 EFFECTS OF ZIRCONIUM AND TIN ON TITANIUM OXIDATION STABILITY. V. V. Glazova and N. N. Kurnakov. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 4, 154-8(July-Aug. 1963). (In Russian)

Oxidation resistance of Ti–Zr–Sn alloys was studied at 500, 700, and 800°C, and effects of Zr and Sn on oxidation resistance of Ti were investigated. It was found that Ti with up to 60% Zr has high oxidation resistance at 500°C. Additions of Sn inhibit oxidation resistance at 700 and 800°C, however, at 1000°C additions of 12 to 14% Sn to Ti–Zr improve oxidation resistance. Additions of Zr to Ti alloys with 5 to 15% Sn inhibit their oxidation resistance at high temperatures, however, alloys with identical contents of Zr but increased amount of Sn exhibit strong oxidation resistance. (R.V.J.)

39496 SIMULATED BOILING WATER REACTOR AND SUPERHEAT REACTOR CORROSION FACILITY. M. D. Fitzsimmons, W. L. Pearl, and M. Siegler (General Electric Co., San Jose, Calif.). Nucl. Sci. Eng., 17: 18-29 (Sept. 1963).

A versatile boiling water and superheated steam facility was developed for out-of-pile corrosion testing of materials that are being used and considered for application in boiling water reactor (BWR) and superheat reactor (SHR) systems. The following capabilities were achieved: simulation of the various environments (other than irradiation) that would contact materials in a Dresden type BWR and an SHR utilizing steam generated therefrom; dynamic fuel-cladding material tests operated with a heat flux of 250,000 Btu/hr-ft^2 for testing tubular type cladding under representative BWR heat transfer conditions; dynamic fuel-cladding-material tests operated with a heat flux of 170,000 Btu/hr-ft^2 for testing tubular cladding under representative SHR heat-transfer conditions; control of oxygen and hydrogen content in the steam and water to simulate the gas conditions from radiolytic water decomposition found in a BWR; and (5) attainment of metal temperatures of 1300°F while superheating steam to 1050°F. (auth)

Fabrication

Refer also to abstracts 39183, 39315, 40312, and 40396.

39497 (ATL-A-138) INVESTIGATION OF THE TECHNICAL FEASIBILITY OF COLD EXTRUSION FOR ZIRCALOY-2 TUBING PRODUCTION. Quarterly Technical Progress Report, October–December 1961. F. E. Weil (Advanced Technology Labs. Div. of American-Standard, Mountain View, Calif.). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-250. 8p. (ATL-D-734; EURAEC-267)

The extrusion of fuel-element-size tubing was continued, and the product at each stage of the sequence of operations is illustrated. The precision die set for piercing is described. Results of first- and second-tube extrusions are reported. Pole-figure studies of the cold-extruded tubing and of commercial tubing indicate that the cold-extruded tubing should have greater burst strength. It is concluded that Zircaloy-2 tubing can be cold-extruded from 1-inch-diameter bar stock, and that the cold-extrusion process is economic. (D.L.C.)

39498 (DMIC-Memo-169) WELDABILITY STUDIES OF THREE COMMERCIAL COLUMBIUM-BASE ALLOYS. P. A. Kammer and R. E. Monroe (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). June 17, 1963. Contract AF33(616)-7747. 20p. (AD-415203)

At the present time, a group of niobium-base alloys is being considered for addition to the Department of Defense Refractory Metals Sheet Rolling Program. Good weldability is one of the requirements for inclusion of alloys in this program. Two alloys currently under consideration are B-66, produced by Westinghouse Electric Corporation, and FS-85, produced by Fansteel Metallurgical Corporation. A third alloy, C-129, produced by Wah Chang and submitted by Boeing Airplane Company, was also included in this evaluation. Samples of these three alloys were obtained for a brief weldability evaluation at Battelle to determine whether the alloys met the target properties established by the Materials Advisory Board, Refractory Metals Sheet Rolling Panel-Alloy Requirements and Selection Group. Room-temperature bend-ductility target properties for fabricable niobium-base alloys are 1T for base metal bends and 2T for welds bent with the weld transverse to the bend axis. Bend tests made on base-metal samples showed that all alloys met the target properties for base metal. Bend tests of welds made in a vacuum-purged controlled-atmosphere chamber showed that only the welds in the FS-85 alloy possessed the desired target properties. (auth)

39499 (DP-306) ULTRASONIC FUSION JOINING OF SINTERED ALUMINUM POWDER MATERIALS TO ALUMINUM ALLOYS. John G. Thomas and Florence R. Meyer (Aeroprojects, Inc., West Chester, Penna). Aug. 1958. For Du Pont de Nemours (E. I.) & Co., Savannah River Lab.

Essentially void-free fusion-type joints of high strength were produced between small specimens of Type M-276 sintered aluminum powder plate and 1100-H14 wrought plate, using a technique consisting of controlled and brief exposure of the ends of both materials to an ultrasonically active coupler face in a bath of molten 1100 aluminum, followed immediately by butt joining and fast cooling. With further development, the process should be adaptable to other types of sintered aluminum powder material and to other joint geometries. (auth)

39500 (GA-3683) ON THE NONHOMOGENEOUS WORK FOR WIRE DRAWING. T. A. Trozera (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Jan. 15, 1963. Contract AT(04-3)-167. 37p.

An idealized theory for rod drawing is developed. Although this theory has the same deficiency as all other existing theories insofar as it does not consider the effect of shearing strains, it does consider quite accurately the important effects of function and strain hardening. Based on computer solutions to the drawing equations, an experimental procedure is presented for determining the nonhomogeneous work arising from the shear strains as a function of reduction in cross-sectional area and of die angle. The results of drawing experiments on Type 1100 alumi-

num are analyzed using the developed procedures, and the results are compared with those of other investigators. A method of estimating the coefficient of friction is developed, and a procedure for determining the equivalent plastic strain due to nonhomogeneous deformation is presented. An empirical relationship between the nonhomogeneous work, die semiangle, and strain is presented. (auth)

39501 (HW-78574) DISSIMILAR METAL WELDS OF CERTAIN SUPERALLOYS AND STAINLESS STEELS. R. L. Knecht (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 1963. Contract AT(45-1)-1350. 27p.

A welding program was conducted in support of the design and construction of the model ATR high temperature gas loop. Sections of $1\frac{1}{2}$-inch schedule 40 pipe of superalloy and stainless steel loop metal candidates were welded by the tungsten-electrode inert-gas process. All possible metal combinations of Hastelloy X, Hastelloy C, Haynes alloy 25, and AISI 316 and 347 stainless steel were made except for Hastelloy X to Hastelloy C and AISI 316 and 347 welded to themselves. There were three general guide lines for welding that were particularly emphasized. First, all the metals were to be in the solution heat treated condition when welded, thereby providing the most desirable metallurgical structure. Second, the pipe was welded with the minimum restraint to avoid any unnecessary stress build up. And third, heat build up was avoided to the extent practical to minimize the heat affected zone and the accompanying thermal stresses. The welds and heat affected zones were physically sound as determined by visual examination, radiography, fluorescent penetrant testing, and macro and microexaminations. Bend tests indicated all welds to be ductile except for those involving Hastelloy C, many of which broke during bending. Faster cooling after welding to curtail second phase precipitation should improve Hastelloy C weld ductibility. Most welds showed full strength efficiency at room temperature as determined by tensile tests. The lowest efficiency was 88%. Joint efficiency at 1800°F is apparently high for welds involving Hastelloy X and Haynes alloy 25 as indicated by a limited number of stress rupture tests. Thermal cycling tests thus far indicate that the dissimilar metal welds do not have a tendency to crack in a simulated loop thermal environment. Welding conditions for the model loop that are less ideal than those of the welding study may produce problems. Thicker metal sections of AISI 347 stainless steel and Haynes alloy 25 welded under restraint may be susceptible to cracking in the heat affected zone during welding or subsequently during loop thermal cycles. (auth)

39502 (NLCO-886) DRILLING URANIUM BILLETS ON A LEBLOND-CARLSTEDT RAPID BORER. R. J. Jansen (National Lead Co. of Ohio, Cincinnati). Sept. 13, 1963. Contract AT(30-1)-1156. 26p.

Solid uranium castings were bored with a LeBlond-Carlstedt Rapid Borer to produce hollow billets for extrusion. The ability of the machine to drill dimensionally accurate billets was demonstrated. Holes up to 2 inches in diameter were bored in billets 20 inches long in less than 10 minutes. Analysis of the tool life and the production capabilities show a cost savings can be obtained by drilling solid billets with this machine rather than casting hollow billets. The cost of drilling is more than offset by the higher casting yield obtained with solid ingots and the lower cost per billet for the graphite mold components. (auth)

39503 (NYO-10606) STUDY ON THE MECHANICAL WORKING CONDITIONS OF NUCLEAR MATERIALS AS RELATED TO ROLLING. Quarterly Report No. 2. C. A. Martinez Vidal and J. A. Sabato (Argentina. Comisión Nacional de Energía Atómica, Buenos Aires). Sept. 1962. Contract AT(30-1)-2927. 14p.

Descriptions are given of: (a) the design, construction, and adjustment of a Ford plane-strain compression die, to be used in the determination of constrained yield stress curves, and (b) the design and construction of a load cell with strain gages to be used in the measurement of the rolling load during rolling. (auth)

39504 (ORNL-TM-675) SS SUPPLEMENTAL MANUAL — PROCEDURE NO. 19. BNL KILOROD PROGRAM. J. A. Swartout (Oak Ridge National Lab., Tenn.). Sept. 6, 1963. Contract [W-7405-eng-26]. 17p.

SS accountability procedures are outlined for the BNL Kilorod Program. The program consists of the preparation of fuel rods containing Th–U^{233} oxide by the Sol-Gel process and loaded by vibratory compaction. (auth)

39505 (EURAEC-462) DEVELOPMENT OF PROCESSES FOR MANUFACTURING URANIUM CARBIDES AND UC-BASED CERMETS. Quarterly Report No. 9, July 1, 1962 to September 30, 1962. (Nuklear-Chemie und-Metallurgie G.m.b.H., Wolfgang bei Hanau am Main, Germany). Work Performed under United States–Euratom Joint Research and Development Program. Contract 088-62-7 RDD. 12p. (A translation).

The construction of the reaction furnace for the semi-continuous preparation of UC was finished. Work is being carried out for eliminating the drawbacks discovered by testing. In the first stage of the reaction furnace, 200 kg of UC were produced by solid-state reaction of UO_2 and graphite. For the skull-melting furnace a centrifugal-casting process was developed by which rods of 30 mm diameter and reproducible carbon content could be cast. One hundred and fourteen rods whose useful (free of shrink holes) length averaged 75 mm were cast. (auth)

39506 (EURAEC-539) BASIC RESEARCH ON SOME BRITTLENESS ASPECTS AFFECTING HIGH TENSILE STEEL WELDED JOINTS. Quarterly Report No. 4, October 1 through December 31, 1962. (Societe Anonyme des Forges et Ateliers du Creusot, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 073-61-12-RDF. 6p. (A translation)

The mechanical tests for tensile strength and impact test values in the hardened non-tempered condition were continued with melts containing alloy elements and impurities. The tensile strength increases noticeably in the addition of Si, Mn, and Cr. As regards the impact test values, Mn, Cr, and Mo raise the transition temperature; nickel lowers it and silicon does not seem to have any appreciable influence. All impurities raise the transition temperature; the element with the greatest influence is phosphorus; Cu, Sn, Sb, and N_2 have a noticeable effect. The mechanical tests in the hardened and tempered condition were made on the melts. The heat treatment consisted of a water quench followed by tempering at 650°C for one hour and cooling in air. All additive elements raise the strength; molybdenum, silicon, and vanadium show the most influence. As regards impact resistance, in the case of the elements refining the gamma grain, aluminum is the most favorable. Niobium and tantalum show little influence and vanadium, titanium, zirconium, and uranium raise the transition temperature. In the case of alloy elements, one meets again the very favorable nickel influence; manganese shows little influence and silicon, molybdenum, and chromium are of embrittling character. In the case of impurities, it was noted

that phosphorus is the most harmful on the impact test values; copper is practically without effect; the other elements are of embrittling character. Supplementary tests on gamma grain growth were made to determine the time-temperature equivalence formula already proposed for holding times exceeding 7 min. The formula can be extended to the specific heat treatments developed by a welding operation (very short holding time and high temperature–1,300°C). All short period tests were made with the RPI machine. (auth)

39507 (EURAEC-601) SIMULATING EQUIPMENT FOR TEST SAMPLES WELDING CYCLES—GLEEBLE MACHINE 501 B CALLED "RPI." Topical Report No. 14, October 1 through December 31, 1962. (Societe des Forges et Ateliers du Creusot, Paris). Work Performed under United States–Euratom Joint Research Development Program. Contract 073-61-12 RDF. 12p. (A translation)

Equipment for examining the reproduction of thermal cycles generated in the course of welding on standard test samples is described. The equipment simulates the metallographic structures of a welded joint under far more favorable conditions for a detailed and systematic research. The Gleeble Machine 501 B, type RPI is provided with an electron control of the fast cycles. Operation and performance of the machine for tensile, strain hardening, grain growth, structure, heat treatment, and cycle testing are discussed. (N.W.R.)

39508 (EURAEC-614) STUDY OF ELEMENTARY CRACKING. PRELIMINARY TESTS IN RESPECT OF THE WELDING METHOD. Quarterly Report No. 1, January 1–March 31, 1963. (Institut de Saudure, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 090-62-12RDF. 10p. (A translation)

As the procurement of Mn–Mo steel plates has been delayed, work was done on the preparation of sample sections and on temperature measurement during welding operations. Fusion line tests and J-Grooving chamfering tests were carried out on AMMO steel, and results of hardness measurements are given. (D.L.C.)

39509 (EURAEC-615) WELDING OF VERY THICK STEELS. Quarterly Report No. 6, January 1 to March 31, 1963. (Ghent. Rijksuniversiteit and Soudometal, S. A., Brussels). Work Performed under United States–Euratom Joint Research and Development Program. Contract 042-61-9 RDB. 201p. (A translation)

Topics covered on the welding of very thick steels include: chemical analyses at various levels through 100 m thick joints, improvement of the tandem automatic welding process, total bend tests carried out on 100 mm thick steel 27 A, improvement of artificial working conditions in automatic welding, improvement of automatic welding products insensitive to prolonged heat relaxation treatment, study of steel 13 C and 23 A transformation zones for automatic welding under artificial working conditions, study of the evolution of impact strengths in terms of the heat treatments applied to the as-welded structures and of the reduction of the volume of passes, study of creep in filler metals, investigation of the bottoms of notches made before welding, Robertson tests on manual welding filler metal and basic metals 13 C and 32 A, and the study of heat treatments for restoring steel C embrittled by 10% strain at 300°C. (N.W.R.)

39510 (EURAEC-617) RESEARCH ON THE RESIDUAL STRESSES RESULTING FROM THE RISING VERTICAL WELDING PROCESS. Quarterly Report No. 5, January 1, to March 31, 1963. (Arcos, S. A., Brussels). Work Performed under United States–Euratom Joint Research and Development Program. Contract 053-61-12-RDB. 96p. (A translation)

Work was continued on the 60mm thick test pieces welded by the electroslag process. On test piece No. 7, the measurement of penetration, measurement of temperatures, and determination on the surface stresses were concluded. Test piece No. 8 was left in abeyance on account of the difficulties encountered in setting up the devices for measuring the stresses in depth. The thermal balance was calculated and the shifts during welding, as well as the distortions and the shifts after welding were measured for test piece No. 9. Additional checks of the temperatures measured by the two methods which were applied were made. The check of the method used for inspecting the degree of relaxation of the stresses was also made. Experiments for perfecting the method determining the residual stresses in depth by strain gauges were made. (auth)

39511 (EURAEC-659) ELECTROSLAG WELDING OF REACTOR STEELS. Quarterly Report No. 8. (Schweisstechnische Lehr-und Versuchanstalt, Duisburg, Germany). Apr. 25, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 046-61-3 RDA. 46p. (A translation)

The desired weld metal compositions were not obtained in all cases with welding tests using composite wire, the quality of which has so far been found to be inferior to that of solid wire of the same weld metal composition. A-c yielded the best notch impact strengths in melting tests in a water-cooled copper chill with Mn–Ni–Mo alloy wire, various currents and polarities being used in the wire, electrode. No satisfactory results were obtained from welding tests in which other commerical welding wires were used. The joint welds made with wire of our own composition were continued and yielded the highest age-hardened notch impact strengths for a-c welding with Mn–Ni–Mo wire. In some welds the microstructure was examined in particular detail. Tests are still being carried out to determine the influence of various heat treatments on the quality of samples welded with Mn–Ni–Mo wire. Welding tests on 13 CrMo 44 steel were begun. (auth)

39512 (EURAEC-667) STUDY OF THE MECHANICAL PROPERTIES OF A WELD MADE ON Mn–Mo PLATE. Special Report No. 4. (Chantiers de l'Atlantique Penhoet-Loire, Paris). Feb. 13, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 054-61-12-RDF. 65p. (A translation)

A study was carried out on the mechanical properties of a weld in an Mn–Mo steel plate in three states: as-welded, after complete heat treatment (annealing + tempering), and after tempering. The welding conditions used are given. Tests carried out included tensile, bend, prismatic tensile, and impact strength tests. It is concluded that the as-welded state has a low strain capacity, low impact strength, and a higher ultimate tensile strength and yield strength than these of the base plate; the tempering alone worsens the mechanical properties; and that annealing + tempering treatment results in mechanical properties close to these of the base plate. (D.L.C.)

39513 (EURAEC-672) METHODS EMPLOYED IN THE FABRICATION OF PRESSURE VESSELS. Quarterly Report No. 5, January 1 to March 31, 1963. (Neratoom, N. V., The Hague). Apr. 26, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 069-61-12-RDN. 42p. (A translation)

In the research involving submerged arc welding with a single welding head, three seams in 200-mm-thick material were completed. The welds were executed with several wire-powder combinations and are now being subjected to destructive examination. Submerged arc welding with a double welding head encountered difficulties. After having replaced the apparatus originally used, in which both electrodes were fed with alternating current, by an auto-welder, one electrode being fed with direct and one with alternating current, a seam was welded without difficulty. In the arc welding with CO_2 shielding, a seam was welded in 200-mm-thick material without mishap. Both these seams are presently undergoing destructive examination. The non-destructive test revealed a number of welding faults. The enclosed carbon dioxide welding process was also applied to a weld seam in 200-mm-thick material. In this case there was a slight degree of penetration at the sides of the weld and an appreciable degree of penetration in the center of the weld. New measures for eliminating this fault finally and permanently are being considered. Ultrasonic examinations of crater seam welds in 2000-mm-long, 200-mm-thick test plates are described and shown. (N.W.R.)

39514 (EURAEC-699) APPLICATION OF A TIME-TEMPERATURE EQUIVALENCE TO THE STUDY OF AUSTENITIC GRAIN GROWTH DURING WELDING CYCLES. Special Report No. 15, January 1, 1963 to March 30, 1963. (Societe des Forges et Ateliers du Creusot, Paris). Work Performed under United States–Euratom Joint Research and Development Program. 13p. (A translation)

The effects of time and temperature on gamma grain growth in steel during welding cycles are studied. The results of this study show that gamma grain growth is related to the parameter already used by Hollomon and Jaffe: P = T (20 + log t). The validity of this equivalence was verified for residences varying from one second to nine hours and welding cycles characterized by quick heating and cooling, and a negligible residence (less than 0.2 sec) at maximum temperature. (N.W.R.)

39515 (EURAEC-769) PLUTONIUM RECYCLE. Quarterly Report Nos. 10–11, January 1 to June 30, 1963. (France. Commissariat a l'Energie Atomique, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 037-60-12-RDF. 11p. (A translation)

The fabrication of plutonium–uranium reactor fuel elements is discussed. (N.W.R.)

39516 THE GRAPHITE PLANT. M. Alles. Energie Nucl., 5: 307-10(June 1963). (In French)

The machining of graphite for nuclear applications consists of a series of classical mechanical operations, but with the necessity of thorough cleanliness and great precision (of the order of 0.01 mm). After a brief description of the graphite-machining plant at Marcoule, details of the tools and machines are given. The two principal operations, boring and surface grooving (giving the final outline to the bored rough shape), are described. (J.S.R.)

39517 ELECTROPOLISHING AND POINTING THIN BERYLLIUM WIRES. F. V. Hunt (Harvard Unv., Cambridge, Mass.). Rev. Sci. Instr., 34: 1154-5(Oct. 1963).

Five-mil Be wires are curved through an angle of 75°, electropolished to a diameter of 1.5 to 2 mils, and given a sharp or rounded point by suitable electropolishing. The resulting product is to be used as a lightweight stylus for a phonograph pickup. (T.F.H.)

39518 HOT PRESSING OF PURE OXIDE CERAMICS [BeO, MgO, CaO, Al_2O_3]. D. N. Poluboyarinov and E. I. Shalnov. Zh. Vses. Khim. Obshchestva im D. I. Mendeleeva, 8: 148-54(1963). (In Russian)

Two types of devices used in hot-pressing pure BeO, MgO, and Al_2O_3 are described. One consisted of a high-frequency generator, hydraulic press, and graphite press heated by induction and controlled by high-frequency current. The other consisted of a tubular graphite resistance furnace located between hydraulic press planes. An analysis was made of the shrinkage, density, microstructure, and thermal resistance of hot pressed BeO, MgO, and Al_2O_3 specimens. (R.V.J.)

39519 INVESTIGATIONS OF CARBON COATING ON URANIUM DIOXIDE BY METHOD OF PYROLYSIS OF HYDROCARBONS IN FLUIDIZED REACTOR. Franciszek Mucha, Tadeusz Adamski, and Bohdan Kalinowski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). 32p. (CONF-207-2). (In Polish)

From Second Yugoslavian Polish Symposium on Uranium Technology and Metallurgy, Zakopane, Poland, Sept. 1963.

The method of pyrolysis of hydrocarbons in fluidized coke bed was used to coat uranium dioxide grains with pyrolytic carbon. On grains prepared by cementing uranium dioxide with pitch and coke compact carbon coatings were also obtained. However, on freshly reduced uranium dioxide no compact carbon coatings were obtained. The rate of growth of the carbon coatings depended on the diameter of grains, falling as the diameter of grains was reduced. The coatings made on previously obtained thick carbon coatings on grains of greater diameter were observed to peel off; some causes of this phenomenon are discussed. The method and some results of determination of the coat material density are described. Determinations for compactness of carbon coatings on uranium dioxide grains were carried out using a method based on a leaching of samples with nitric or citric acid. (P.C.H.)

39520 SILICONE RUBBER COMPOSITIONS. (to Abbott Labs.). British Patent 937,126. Sept. 18, 1963. Priority date Oct. 26, 1960, United States.

A silicone-rubber composition, in which radioisotopes are incorporated with minimal risk of contamination during manufacture and application, is patented. The composition is prepared by combining a rubber-forming silicone gum with a radioisotope adding a tin-containing curing catalyst, and curing the mixture at about room temperature. The composition may be cured into a desired form, such as sheets or blocks, or it may be cured within small-diameter plastic tubing. (M.P.G.)

39521 DISTANCE-ROD FOR PROTECTIVE WALLS. Wilhelm Janowsky (to Leybold-Hochvakuum-Anlagen GmbH). German Patent 1,149,155. May 22, 1963. Filed Nov. 18, 1960.

The protective wall described consists of two outer shells of sheet metal, the space between them being filled with concrete. Distance rods are attached to the shells at both ends to ensure a predetermined distance and to avoid distortions. In order to prevent leakage of radiation along these rods they are made of metal or plastic strips which are twisted along the axis. (NPO)

Properties and Structure

Refer also to abstracts 40384 and 40392.

39522 (AD-291849) INTERNAL STRESSES IN MODEL CERAMIC SYSTEMS. III. Summary Technical Report. Richard M. Fulrath and Joseph A. Pask (California. Univ., Berkeley. Inst. of Engineering Research). Nov. 1, 1962. Contract AF49(638)-4. 15p.

A unique fabrication procedure of vacuum hot-pressing multicomponent systems was used to form model ceramic systems for studying internal stresses. Methods of analysis of internal stress combining the microstructural features and x-ray diffraction patterns were developed. Three different particle shapes dispersed in glassy matrices were studied. Internal stresses were found to be of secondary importance in systems with strong interfacial bonds and of primary importance in systems in which strong interfacial bonds were not developed. (auth)

39523 (AD-296188) INVESTIGATION OF THEORETICAL AND PRACTICAL ASPECTS OF THE THERMAL EXPANSION OF CERAMIC MATERIALS. Report No. P1-1273-M-12. Henry P. Kirchner, Howard A. Scheetz, W. Richard Brown, and Harold T. Smyth (Cornell Aeronautical Lab., Inc., Buffalo). July 1962. Contract NOrd-18419. 153p.

Several methods were used to predict the thermal expansion coefficients of pure, single-phase ceramics. The predictions were extended to cover 1700 pure phases. Based upon these calculations a number of phases, predicted to have low values of thermal expansion coefficient, were synthesized and the thermal expansion properties of these materials were measured. Several of these were found to be low-expansion materials. The thermal expansion properties of cubic UP_2O_7 are particularly interesting. This material expands with increasing temperature up to about 400°C. Above this temperature the crystal contracts, returning to its room temperature length at about 1000°C. These properties are believed to be unique. Variation of the thermal expansion anisotropy by addition of solid solution atoms to several base crystals was attempted. Addition of vanadium to rutile (TiO_2) resulted in a significant decrease in thermal expansion anisotropy. Vanadium additions to cassiterite (SnO_2) which has the same structure as rutile, also caused a significant decrease in thermal expansion anisotropy. (auth)

39524 (AD-296987) IMPROVED OXIDATION RESISTANCE OF MOLYBDENUM BY ALLOYING WITH RARE EARTH AND OTHER SELECTED METALS. Interim Report No. 7, November 1, 1962–December 31, 1962. (Colorado School of Mines Research Foundation, Inc., Golden). Feb. 1, 1963. Contract NOw-62-0305-d. 5p.

The diffusion rates of hafnium and of oxygen in the alloys during the process of internal oxidation obey the Arrhenius law, as evidenced by straight line plots of log D vs 1/T. This is substantiated by data at three temperatures, 1100, 1200, and 1300°C. (auth)

39525 (AD-416459) DESIGN DATA STUDY FOR COATED COLUMBIUM ALLOYS. Bimonthly Report No. 2, May 1, 1963 through July 1, 1963. (TAPCO. Div. of Thompson Ramo Wooldridge Inc., Cleveland). Aug. 1, 1963. Contract NOw 63-0471c. 55p. (TM-3770-67)

A series of preliminary evaluation tests was conducted with Pfaudler and TRW protective coatings on 30-mil B-66 and X-110 niobium alloy sheet. Two modified silicide coatings applied by one and two-cycle Pfaudler coating processes and the TRW Cr–Ti–Si coating were comparatively evaluated on the two alloys, prior to initiation of the Design Data Study. Data are presented from one atmosphere cyclic oxidation tests of the six coating-base metal systems at 1600, 2000, 2300, and 2600°F. The influence of elevated temperature-reduced pressure exposure on the various coating systems was studied for 1 and 2 hour 2500°F exposures at 10^{-1} and 1 mm pressures. Post-oxidation in air at 2600°F was utilized as the criteria for evaluating reduced pressure coating degradation. Room-temperature bend ductility data are presented for tests on as-coated sheet and on coated sheet after cyclic oxidation for 100 hours at 2000°F and 4 hours at 2600°F. Smooth and notch tensile data are reported for tests performed on uncoated and coated sheet at room temperature and 1200°F. The tensile behavior of coated B-66 and X-110 alloys is discussed relative to that of previously studied FS-85 niobium alloy. (auth)

39526 (AERE-M-1282) THE EFFECT OF THE ADDITION OF FOREIGN ATOMS ON THE MAGNETIC PROPERTIES OF THE NICKEL IRON ALLOY Ni_3Fe. J. Stephen (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Aug. 1963. 16p.

The magnetic properties of the nickel–iron alloy Ni_3Fe can be modified considerably by adding atoms of a third element. A survey is presented of the effects of certain elements on Ni_3Fe and special consideration is given to those elements which may improve the neutron irradiation resistance of this alloy at elevated temperatures. (auth)

39527 (AROD-2530:2) THE STRENGTHENING OF COLUMBIUM AND COLUMBIUM ALLOYS BY INTERSTITIAL ALLOYING ELEMENTS. F. V. Lenel and W. R. Hulsizer (Rensselaer Polytechnic Inst., Troy, N. Y.). July 31, 1963. 35p.

Solid solutions of oxygen in Nb were prepared at 1250° using pure Nb ribbon and introducing a known quantity of oxygen. The lattice parameter of each of the specimens was measured and related to the oxygen concentration in the respective specimens in order to determine the relationship between lattice parameter and oxygen content. The solid solution specimens having oxygen concentrations near 3.6 at. %, the solubility limit at 1250°C, are supersaturated solutions at lower temperatures. The specimens were subjected to isothermal heat treatments at various temperatures in the range from 850 to 1250°C. The course of precipitation was followed through measurement of the lattice parameter of the matrix. Upon completion of the precipitation process, the lattice parameter remained constant. The constant lattice parameter was then related to oxygen content using the relationship of lattice parameter-oxygen content, the solubility limit at each precipitation temperature thus being obtained. (auth)

39528 (ASD-TDR-62-25(Pt.II)) INVESTIGATION INTO THE TUNGSTEN-RICH REGIONS OF THE BINARY SYSTEMS TUNGSTEN–CARBON, TUNGSTEN–BORON AND TUNGSTEN–BERYLLIUM. H. J. Goldschmidt, E. A. Catherall, W. M. Ham, and D. A. Oliver (Birmingham Small Arms, Ltd., Birmingham, England). June 1963. Contract AF61(052)-306. 80p.

The solid solubility of boron and beryllium in tungsten, together with the attendant problems concerning the tungsten-rich borides and beryllides in equilibrium with W, and which are liable to precipitate, are discussed. Brief supplementary data are given on the W–C system, following the previous investigation. The study of the solubility of boron in tungsten shows this to be approximately 0.2 at. % B at 2500°C, decreasing with temperature. The atomic nature of this solution presents a special, and it is believed, novel problem, in that it can be interstitial and substitutional. $W–W_2B$ forms a eutectic system, the eutectic temperature being about 2600°C. A high-boron compound WB_4 was observed. In the tungsten–beryllium system that presented some special hazards which are described, the solubility of Be in W is found to be approximately 5 at. % Be at the eutectic temperature (≈2100°C).

The solubility limit does not vary appreciably down to 1800°C and decreases to about 3 at. % Be in the 1000 to 1300°C range. The solid solution is substitutional, and lattice spacing variations are described. The equilibrating phase is WBe_2 (hexagonal Laves structure). The diberyllide precipitates from the primary (W,Be) solution and is shown to have itself a significant homogeneity range. (auth)

39529 (DRI-2117) DETERMINATION OF THE NIOBIUM-RICH REGION OF THE TERNARY PHASE DIAGRAMS, NIOBIUM–TUNGSTEN–HAFNIUM AND NIOBIUM–TUNGSTEN–ZIRCONIUM. Quarterly Report No. 4. Albert S. Yamamoto (Denver. Univ. Denver Research Inst.). Sept. 1963. Contract AT(11-1)-1092. 7p.

Isothermal annealing of the niobium–tungsten–hafnium alloys at 1600°C and 1300°C was completed while the 1100°C anneal has been partially finished. The heat treated samples are currently under preparation for metallographic examination. The alloy preparation for the niobium–tungsten–zirconium system will be resumed using the newly acquired zirconium metal. The 1300°C and 1100°C isotherms for the niobium–aluminum–zirconium system were determined and are included. The unknown phase reported previously was identified as the Nb_2Al phase that has an extensive homogeneity range with respect to zirconium as the ternary addition. (auth)

39530 (EURAEC-650) THE EFFECT OF RADIATION ON THE DUCTILE-BRITTLE TRANSITION IN PRESSURE VESSEL STEELS. Special Report No. 1 ON THE POSSIBLE RELATIONSHIP BETWEEN TWINNING AND BRITTLE FRACTURE IN IRON AND OTHER BODY-CENTRED CUBIC METALS. PART ONE—A SURVEY. E. Anderson and J. Spreadborough (Battelle Memorial Inst. International Div., Geneva). Apr. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 095-62-12-RDS. 43p.

A review is presented of the experimental evidence and interpretations of the relations between twinning and brittle fracture in body-centered cubic metals and alloys. The relations between deformation behavior and twinning are shown to fall into three groups according to grain size, and the mechanisms which are operative in each group are discussed. The effects of composition on the relations are also discussed. A schematic presentation of the tensile deformation behavior of Armco iron is given. (D.L.C.)

39531 (EURAEC-689) RESEARCH TO DETERMINE THE LONG-TERM MECHANICAL PROPERTIES OF METALS SUBJECTED TO MECHANICAL STRESS AT ELEVATED TEMPERATURES AND NEUTRON IRRADIATION. W. Siegfried (Battelle Memorial Inst. International Div., Geneva). [nd]. Work Performed under United States–Euratom Joint Research and Development Program. Contract 100-62-12-RDS. 111p.

The evaluations of the results of time-to-rupture tests executed with different steels show that it is possible to find a thermodynamic system which represents with great precision the strength as a function of temperature and time. In such a system the heat of activation is considered as a function of the temperature and the entropy of activation as a function of the stress. It is possible to introduce mean values of these functions with reference to time. The comparison of the results of the new method of evaluation with direct measurement of the heat of activation for the creep process, as made by Sherby/Dorn, shows that it is possible to determine the heat of activation and entropy of activation for the creep process of aluminum by the evaluation of temperature tests. This fact allows one to obtain certain information about the changes in structure taking place during creep in a complex steel. Results are presented on the creep-rupture properties of steels. (N.W.R.)

39532 (EURAEC-693) PHYSICAL PROPERTIES OF UO_2 SINGLE CRYSTALS. Final Report No. 1, October 1961–February 28, 1963. (Mol, Belgium. Centre d'Étude de l'Énergie Nucléaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 063-61-10RDB. 70p.

The sublimation method for the preparation of large single crystals of UO_2 is described. The first results of the experiments on controlled oxidation of UO_2 crystals are briefly reported. The experimental methods for the study on diffusion of U and sintering mechanisms in UO_2 are discussed. Defects in as-grown, annealed, slightly deformed, and irradiated UO_2 crystals were studied by transmission electron microscopy. The deformation of the specimens was done in the microscope; irradiations up to 10^{15} nvt were employed. In order to collect experimental evidence on the formation of fission tracks lattice defects, and fission tracks in other nonmetallic crystals were also investigated. Electrical conductivity measurements between 90 and 800°K were performed on UO_2 single crystals with composition in the range $UO_{2.000}$ to $UO_{2.007}$ using Van der Pauw's method. The activation energies calculated from the log σT vs. $1/T$ curves vary between 0.28 and 0.20 ev depending on the U/O atomic ratio. Hall effect measurements by dc and ac techniques yielded no measurable response ($\mu < 0.015$ cm^2 v^{-1} sec^{-1} at room temperature). An apparatus allowing thermoelectric measurements on UO_2 single crystals between 80 and 320°K was constructed. All samples showed p-type conduction. The Seebeck coefficient was of the order of 0.5 mv/°K and remained rather constant in the temperature region investigated. The study of the coupling constant and the jump probability of carriers in UO_2 shows that the latter are "small polarons," so that the band model does not apply. The behavior of the carriers as predicted by theory (hopping motion, activated mobility, change of the effective mass with temperature) is described. Tunneling of the carriers is not important. The optical absorption spectrum of UO_2 single crystals was measured at room temperature. The absorption edge is located at about 2.18 ev. This absorption probably corresponds to band gap transitions. An apparatus for thermal conductivity measurements between liquid helium and room temperature was constructed. The preliminary measurements have already shown the existence of a minimum of the thermal conductivity between 4 and 100°K. As to the high-temperature conductivity, the apparatus constructed does not yet give full satisfaction and has to be improved. The results obtained thus far are rather similar, at least up to 500°C, to those of J. L. Bates. (auth)

39533 (EURAEC-727) THE DEVELOPMENT OF A NEW DETERMINATION OF THE DUCTILE-BRITTLE TRANSITION TEMPERATURE. Quarterly Report No. M-63-728-26150, April 1, 1963–June 30, 1963. H. C. van Elst (Netherlands. TNO. Centraal Laboratorium, Delft). July 1, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 068-61-11-RDN. 37p.

Determination of Stress Waves in the Robertson Test. Direct framing camera recordings were made of a running brittle fracture in low-carbon steel plates and of the emission of stress waves. Generation of Stress Waves with Explosive and Electrical Means. A recording method using small cylinder condensers was developed for explosive

stress waves. Spark switches were used in the electrical generation of stress waves. Development of A Test Method To Determine the Ductile-Brittle Transition Temperature in Steel on Small Specimens. Tests on three low-carbon steels are described. (D.L.C.)

39534 (EURAEC-791) RESEARCH TO DETERMINE THE LONG-TERM MECHANICAL PROPERTIES OF METALS SUBJECTED TO MECHANICAL STRESS AT ELEVATED TEMPERATURES AND NEUTRON IRRADIATION. Quarterly Report No. 2. W. Siegfried and A. Bard (Battelle Memorial Inst. International Div., Geneva). Aug. 7, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 100-62-12-RDS. 18p.

Research progress made in gathering data for determining time-to-rupture behavior of metals is summarized. Relations between energy and entropy of activation for the formation of rupture are discussed. (N.W.R.)

39535 (GA-3856) OBSERVATION OF DISLOCATIONS IN A TANTALUM SINGLE CRYSTAL. T. A. Trozera and J. O. Gardner (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Jan. 31, 1963. Contract AT(04-3)-167. 8p.

Optical and transmission electron microscopic studies were made on a zone-refined Ta single crystal which had been rolled to ~90% reduction of area at room temperature. The optical microscopic observations revealed a quite well defined cell structure delineated by etch pits. In the transmission electron micrographs, loops, elongated loops, and cusps were observed, and a cell structure appears to be forming after ~90% reduction. Dislocation densities of 10^9 to $10^{10}/cm^2$ were calculated in areas of high density. (D.L.C.)

39536 (HW-78424) THE STRAIN AGING AND HEAT TREATMENT PROPERTIES OF N-REACTOR CONNECTOR TUBES. H. J. Pessl (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 30, 1963. Contract AT(45-1)-1350. 22p.

A study was conducted to determine the susceptibility to strain aging and the effect of stress-relief annealing on the properties of N-reactor connecting tubes made from A-106 Grade B high-carbon steel. The tests included impact tests, weld tests, tensile tests, and tube-flattening tests. It is concluded that the properties are in line with ASTM requirements for this carbon steel, except for the presence of extensive nonmetallic inclusions in the microstructure of the as-received and stress-relieved tube samples. These structural defects may have caused the low impact strength values. (D.L.C.)

39537 (IITRI-B6012-2) STUDIES OF THE BRITTLE BEHAVIOR OF CERAMIC MATERIALS. Quarterly Report No. 2, April 15, 1963 to July 15, 1963. N. M. Parikh and W. Rostoker, eds. (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Aug. 15, 1963. Contract AF33(657)-10697. 149p.

The phenomena associated with the fracture of ceramic oxides are studied. The nature of strength and failure in MgO and Al_2O_3 is described for various environments and temperatures. Topics covered include: strain effects in bending, internal friction in mono- and polycrystalline ceramics, surface and fracture energy of precracked plates, fracture mechanisms, effects of impurities on the porosity of ceramics, high-temperature deformation, dislocation studies in polycrystalline ceramic materials, effects of polyaxial stresses on fracture behavior, influence of surface treatment on strength of oxides, residual stresses in oxide ceramics, effects of grain size and porosity on transverse bend strength, and hot extrusion of alumina and magnesia. (N.W.R.)

39538 (MSAR-63-125) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report 36, August 1963. (MSA Research Corp., Callery, Penna.). Sept. 17, 1963. Contract AT(11-1)-765. 31p.

A research program is being conducted on the effects of reactor grade sodium and contaminants in sodium on Type 316 stainless steel and 2¼ Cr–1 Mo steel. Tensile, creep, stress-to-rupture, and fatigue tests were carried out on specimens in sodium, helium, and air. The results for 316 stainless steel indicate a lower stress for a creep rate of 0.1%/1000 hr in 1200°F sodium and helium than in air, while these for 2¼ Cr–1 Mo steel indicate a lower stress in 1100°F sodium and a higher stress in helium than in air for the same creep rate. Higher oxygen contents (300 ppm) in 1100°F sodium led to shorter rupture times in stress-to-rupture tests on 2¼ Cr–1 Mo steel, but the difference decreases with stress. Creep tests indicate lower creep rates for higher oxygen contents in sodium. (D.L.C.)

39539 (NAA-SR-8538) THERMAL EXPANSION OF URANIUM MONOCARBIDE. R. Mendez-Peñalosa (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 30, 1963. Contract AT(11-1)-Gen-8. 23p.

The influence of the carbon content on the thermal expansion of arc-cast UC near the stoichiometric composition was examined. Expansion measurements were made on samples which varied from 4.35 to 5.24 wt % carbon, over a temperature range that, for the higher carbon content samples, extended to about 2000°C. The influence of free uranium in the hypostoichiometric range was observed. The thermal expansion of all the samples was similar, up to 600°C. At 700 and 780°C, a difference in the expansion behavior was observed between hypostoichiometric and hyperstoichiometric samples. These changes can be related to the α-to-β, and β-to-γ transformation of free uranium. The expansion of hypostoichiometric UC increases rapidly above 850°C. This sharp increase, observed on sintered UC with 4.4 wt % carbon by other authors, is presumably caused by free uranium, and may be caused by the larger thermal expansion coefficient of γ-uranium and the release of forces accumulated in the grain boundaries of UC near the melting point of uranium. (auth)

39540 (NP-13145) PREPARATION AND EVALUATION OF HIGH-PURITY BERYLLIUM. Final Report, October 1961–October 1962. G. E. Spangler, M. Herman, E. J. Arndt, D. B. Hoover, V. V. Damiano, G. S. Tint, and C. H. Lee (Franklin Inst. Labs. for Research and Development, Philadelphia). Contract NOw-62-0536-d. 73p. (F-B1933)

Production and properties of high-purity beryllium are evaluated. Topics covered include: preparation of beryllium by zone refining, conversion of zone refined beryllium into a fine grain size polycrystalline material, mechanical property evaluation of single crystals, hot rolling, hot swaging, texture studies and mechanical properties of polycrystals, fluorescent analyses, electron transmission microscopy, deformation of polycrystals, eddy current resistivity, measurement of self-diffusion in beryllium, and density measurements of beryllium. (N.W.R.)

39541 (ORNL-TM-91) METALLOGRAPHY OF PYROLYTIC CARBON COATED AND UNCOATED URANIUM CARBIDE SPHERES. C. K. H. DuBose and R. J. Gray

(Oak Ridge National Lab., Tenn.). Mar. 21, 1962. Contract W-7405-eng-26. 40p.

Metallographic techniques are described which were developed for examining coated and uncoated uranium carbide particles, both in the unsupported condition and in graphite matrices. The structural and compositional variations in various batches and within a given batch are presented, and the effects of various heat treatments on the particles and the coatings are described. (D.L.C.)

39542 (TID-19465) AN EVALUATION OF THE ROLE OF DEFORMATION TWINNING IN THE PLASTIC DEFORMATION OF ZIRCONIUM. Quarterly Progress Report No. 8, April–June 1963. R. E. Reed-Hill (Florida. Univ., Gainesville. Engineering and Industrial Experiment Station). Aug. 1963. Contract AT(38-1)-252. 49p.

The results of the investigation of kinking phenomena are presented. The most common type of kinking conforms to bending as a result of slip on basal planes. Kinking occurs primarily in grains unfavorably oriented for prism slip, and is therefore competitive with twinning. At low temperatures twinning is the predominant means of deformation; at high temperatures it is kinking. Direct evidence for basal slip in the form of slip line traces on external surfaces is presented. The mechanisms by which the shear deformation of a twin is transmitted across a grain boundary are described and illustrated. These include cooperative twinning, simple slip, kinking, and the formation of accommodation kinks. (auth)

39543 (UCRL-10701) PREDICTION OF HIGH TEMPERATURE METALLIC PHASE DIAGRAMS. Leo Brewer (California. Univ., Berkeley. Lawrence Radiation Lab.). July 1963. Contract W-7405-eng-48. 100p.

The Engel correlation between electronic configurations and crystal structures of metallic phases is confirmed and applied to the binary and multicomponent systems of the thirty metals of the three transition series from the alkali metals to the nickel-platinum group. The use of the Engel correlation to obtain electron configurations and the application of internal pressures of the metals to the regular solution theory together with consideration of the sizes of metal atoms makes possible the prediction of unknown phase diagrams. Diagrams are given as projections upon a composition scale and composition ranges given are the maximum extent over the entire temperature range of the solid phases. Of the two billion possible multicomponent phase diagrams of the thirty metals, at least one and a half billion are readily obtained from the figures, tables, and text and methods are described for extending the procedures for prediction of phase diagrams to additional diagrams outside the range of metals considered. (auth)

39544 (EURAEC-563) SINTERED URANIUM OXIDE. SINTERING TECHNOLOGY. BEHAVIOR UNDER IRRADIATION. Quarterly Report No. 9, October 1 to December 31, 1962. (France. Commissariat a l'Energie Atomique, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 031-60-10-RDF. 78p. (A translation)

Work on the detection of slow reoxidation rates by microscopic examination of sintered UO_2 was concluded; by means of this method it is possible to detect contaminations by air, which cannot be revealed by chemical analysis. When the re-oxidation took place during the cooling subsequent to sintering in a reducing atmosphere, it was possible to detect U_4O_9 precipitates at the surface of a sample whose O/U ratio increased by less than one digit in the third decimal place. The study of superficial re-oxidation of sintered uranium oxide is being carried out by a radiocrystallographic method. The diagrams obtained after various re-oxidation treatments at low temperature were drawn and compared. The apparatus used for measuring the thermal conductivity of sintered uranium oxide at high temperature by radial flow was considerably altered by taking into account the preliminary results, and was temperature calibrated. The last tests of the irradiation capsule at 1400°C were performed in the rear swimming pool of the Mélusine pile and took place quite satisfactorily. The trapping circuit associated with the capsule was installed in the vicinity of the reactor and the complete circuit passed the acceptance tests. The final capsule which takes due account of slight modifications, is now under construction. (auth)

39545 (EURAEC-599) RESEARCH ON EMBRITTLEMENT IN THE HARDENED CONDITION. INFLUENCE OF ALLOYING ELEMENTS AND IMPURITIES. Special Report No. 11, October 1 through December 31, 1962. (Société des Forges et Ateliers du Creusot, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 073-61-12-RDF. 16p. (A translation)

The effects of alloying additives (Cr, Mn, Mo, Ni, Si) and of impurities (Sb, Cu, N_2, P, Sn) on the transition temperature of steel were studied at various Charpy Vee notch impact values. Of the alloying additives, Si has little effect, Cr has a noticeable embrittling effect at contents >3%, Mn has a similar effect at contents >1.5%, and Mo has a greater effect for all contents down to 0.5%, while Ni increases the resilience. Of the impurities, P has the most deleterious effect on the resilience, while N_2, Sn, and Sb have an intermediate effect, and Cu has practically no effect. The effects of these alloying additives and impurities on the electrical resistance of steel were also investigated. (D.L.C.)

39546 (EURAEC-600(Pt.3)) RESEARCH ON EMBRITTLEMENT IN THE HARDENED AND TEMPERED CONDITION. Special Report No. 12, October 1 through December 31, 1962. (Société des Forges et Ateliers du Creusot, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 073-61-12 RDF. 25p. (A translation)

The effects of impurities and alloying elements on the mechanical properties, particularly the brittleness, of low martensites in the tempered and hardened condition are determined. (N.W.R.)

39547 (EURAEC-636) BASIC STUDY OF VARIOUS FORMS OF EMBRITTLEMENT AFFECTING JOINTS WELDED IN HIGH TENSILE STEEL. Quarterly Report No. 5, January 1, 1963–March 31, 1963. (Societe des Forges et Ateliers du Creusot, Paris). Work Performed under United States–Euratom Joint Research and Development Program. 23p. (A translation)

The effects of impurities and alloying elements on the mechanical properties of low carbon martensites in the hardened, tempered, and embrittled condition are determined. The effects of boron, carbon, nickel, and titanium contents on the properties of steel are reported. Other topics covered briefly are: gamma grain growth in welding cycles, mesh parameter in the martensitic condition, and determination of the transformation points during fast cooling using the magnetothermodynamic apparatus. (N.W.R.)

39548 (EURAEC-646) SINTERED URANIUM OXIDE—SINTERING TECHNIQUES. BEHAVIOR UNDER IRRADIATION. Quarterly Report No. 10, January 1 to March 31,

1963. (France. Commissariat a l'Energie Atomique, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 031-60-10-RDF. 70p. (A translation)

In the course of the study on sintering of UO_2 powders with high specific surface, it was found that the results of pressing and sintering do not give satisfactory reproducibility. Behavior when subjected to heat treatment, as well as the capacity of retaining the fission gases, of products prepared by the two techniques previously described, slow cycle at 1400°C, accelerated cycle at 1650°C, was evaluated. Measurements of thermal conductivity of sintered UO_2 were carried out in the axial heating apparatus by the method of drifts and a method of stationary conditions. It was found: that the various representative curves of k (T) show a minimum corresponding to the values of T between 1300 and 1800°C, that this minimum occurs at a temperature which is all the higher as the injected thermal power corresponding to the stationary condition under consideration increases, and that the thermal conductivity measured in this manner is almost constant and even decreases beyond 2000°C. The tests of specific surface measurements of glass marbles or of sintered objects by the adsorption of neutron-activated mercury led to the conclusion that in the field under study (adsorption isotherm 26°C), the quantity of mercury adsorbed upon the glass is a maximum of $1/100$ of that corresponding to the monomolecular layer $p/p_0 < 1$. Measurements of the diffusion coefficient of industrial sintered UO_2 having a density of 10.5 were carried out in the "on-the-table-loop," the fission-product xenon being carried along by the helium, at various temperatures ranging from 1000 to 1400°C. This led to the conclusion that the activation energy within the temperature range below 1400°C is of 90 kcal/mole. As preliminary study of the count of small half life isotopes considered in the Medicis loop, a diffusion test of a freshly irradiated sample of UO_2 was successfully carried out: the Xe^{133}, Xe^{135}, and Xe^{135m} isotopes were detected by gamma spectrometry. (auth)

39549 (EURAEC-698) STUDY OF EMBRITTLEMENT IN THE QUENCHED, TEMPERED AND EMBRITTLED CONDITION. Special Report No. 13, January 1, 1963–March 31, 1963. (Societe des Forges et Ateliers du Creusot, Paris). Work Performed under United States–Euratom Joint Research Development Program. Contract 073-61-12-RDF. 19p. (A translation)

The effects of impurities and alloying elements on the mechanical properties, particularly the brittleness, of low carbon martensites in the hardened, tempered, and embrittled condition are determined. (N.W.R.)

39550 ORDER AND DISSOCIATION IN α – IRON – BERYLLIUM ALLOYS. M. v. Heimendahl and U. Heubner (Institut fur Metallkunde der Bergakademie Clausthal, Deutschland, Ger.). Acta Met., 11: 1115-17(Sept. 1963). (In German)

Iron alloys with 12.9, 21.0, and 29.4 at.% Be were homogenized at 1170°C and quenched in water to room temperature. In subsequent precipitation of the 29.4% alloy at temperatures under 520°C, the unordered α-mixed crystals were transformed into ordered α'-mixed crystals with the same chemical composition. The order state is of the Fe–Al type and is metastable. With prolonged precipitation it decays into a disordered stable phase poor in Be. Precipitation of the 21.0% alloy produces a Be-poor metastable α-phase and a Be-rich ordered α'-phase. The dissociated α and α' phases lie plate-like side by side in the same orientation. A lattice modulation is present in the (100) direction. The wavelengths of the lattice modulation show a linear increase with the length of precipitation. An activation energy of 58 kcal/mol was determined. Alloys with 12.9% dissociate metastably in the same manner as the 21.0% alloys. The iron-rich side of the phase diagram is shown. (J.S.R.)

39551 ON THE TEMPERATURE DEPENDENCE OF THE YIELD STRESS OF NIOBIUM. H. J. Harding (Univ. of Sheffield, Eng.). Acta Met., 11: 1189-90(Oct. 1963).

The effects of temperature on yield stress of niobium crystals showed that a change of slope occurs at approximately 175°K. Specimens tested below this temperature were examined for evidence of twinning, which was found to occur only occasionally at 77°K. When the nitrogen content of the specimens was increased to from 42 to 85 ppm, twinning was found to occur consistently at 77°K but not at 86°K. Hydrogen had the same effect when increased from 2 to 100 ppm. When the oxygen content was increased from 40 to 800 ppm, twinning was not observed at any temperature. Thus it appears that twinning is not highly dependent upon interstitial content. All three elements tended to decrease the temperature dependence of yield stress at temperatures above the anomalous region but did not produce any marked effect at lower temperatures. (P.C.H.)

39552 ROTATING DISK APPROACH FOR CAVITATION DAMAGE STUDIES IN HIGH TEMPERATURE LIQUID METAL. R. W. Kelly, G. M. Wood, H. V. Marman, and J. J. Milich. Am. Soc. Mech. Engrs., Paper No. 63-AHGT-26(1963). 9p.

A rotating disk test unit was developed to determine the comparative cavitation damage resistance of Nb, Mo, and Ta alloys in liquid Li at temperatures to 2000°F. Results of water tests on the apparatus and a description of the method of test operation and specimen examination procedures are given. Application of the method to testing liquid-metal circulating pumps in space power propulsion systems is discussed. (TCO)

39553 CRYSTAL STRUCTURE OF STRONTIUM METAL ABOVE 25 KBAR AND ITS RELATION TO YTTERBIUM. D. B. McWhan and A. Jayaraman (Bell Telephone Labs., Inc., Murray Hill, N. J.). Appl. Phys. Letters, 3: 129-31 (Oct. 15, 1963).

The electric resistivity and x-ray-diffraction pattern of Sr metal were obtained at regular pressure intervals up to 42 kbar. The results indicate that the bcc phase found above 557°C at 1 atm is the same as the bcc pressure-induced phase at 42 kbar and room temperature and that the fcc–bcc phase boundary, commencing at 557° at 1 atm, intersects the pressure axis near 35 kbar at room temperature. The existence of a triple point above room temperature and below this pressure appears tenuous. On the basis of the similarity of Sr and Yb properties, the results indicate that 6s, 6p, and 5d electronic bands are involved in the Yb semiconductive transition and that the 4f electrons are not involved in the fcc to bcc transition in Yb. (D.C.W.)

39554 ON THE PERMEATION OF IODINE THROUGH GRAPHITE. Takashi Mukaibo and Yoichi Takahashi (Tokyo Univ.). Bull. Chem. Soc. Japan, 36: 629-32(June 1963). (In English)

The process of iodine permeation through graphite was found to consist mainly of a simple gas flow through the pore volumes, just as in the case of inert gases. The chemical interaction between iodine and graphite was observed to be negligibly small. At temperatures ranging from 90 to 160°C, and under a corresponding pressure of

iodine vapor below 400 mmHg the rate of iodine permeation was observed to be almost linearly proportional to the pressure of iodine. It was concluded that the Knudsen flow was the predominant element of the total flow. The ratio of the flow rates for air and iodine, which were interpolated to the value under the same conditions, was calculated to be 2.68 ~ 2.85. The rate of iodine permeation was also observed to decrease in the presence of argon gas, even in the region of Knudsen flow. It was found that the rate is roughly inversely proportional to the pressure of argon gas. The dusty gas model was adapted to give a reasonable explanation of this phenomena. (P.C.H.)

39555 ZIRCONIUM COATINGS. Galvano, 32: 379-82 (May 1963). (In French)

A study was made of effects of temperature, pressure, and circulation rate of iodine on Zr deposition rate during plating of Mo, steel, stainless steel, uranium, and Mo-plated stainless steel plates using ZrI_2 sponge. A review of corrosion, hardness, ductility and shock resistance properties of Zr deposits is included. (Rev. Metal Lit., 20: No. 9, Sept. 1963)

39556 LESS COMMON METALS FOR PROCESS EQUIPMENT. E. M. Sherwood. Ind. Eng. Chem., 55: No. 10, 59-64(Oct. 1963).

A review is presented on publications dealing with less common metals for process equipment. The fabrication techniques, alloys, and properties for Be, Cr, Hf, Mo, Nb, Re, Ta, W, and Zr for use in aerospace, cryogenic, and nuclear engineering technology are briefly discussed. 104 references are included. (P.C.H.)

39557 THERMAL STABILITY OF Ni_2Al-Ni_3Nb ALLOYS. R. S. Mints, G. F. Belyaeva, and Yu. S. Malkov. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 4, 151-3(July-Aug. 1963). (In Russian)

A phase diagram was constructed at 800 and 900°C, and thermal resistance was studied as a function of composition. The highest thermal resistance was found with 40 to 50 at. % Ni_3Nb and with 90 wt % Ni_3Nb; the lowest with 70 wt % Ni_3Nb. The lowest creep was observed with 90 at. % Ni_3Nb and 10 at. % Ni_3Al, the highest creep was noticed at the eutectic point (70 at. % Ni_3Nb). (R.V.J.)

39558 TITANIUM-NIOBIUM-CHROMIUM SOLIDUS SURFACE. K. I. Shakhova and P. B. Budberg. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 4, 159-60(July-Aug. 1963). (In Russian)

A solidus diagram was constructed for Ti-Nb-Cr alloy at the Ti-Nb zone and the cross section between $TiCr_2$-$NbCr_2$. The diagram exhibited a wide range of solid solution concentrations based on Ti, Nb, $TiCr_2$, and $NbCr_2$. (R.V.J.)

39559 DIFFUSIONLESS PHASE TRANSFORMATIONS IN ZIRCONIA AND HAFNIA. G. M. Wolten (Aerospace Corp., El Segundo, Calif.). J. Am. Ceram. Soc., 46: 418-22(Sept. 1963).

A study, by high-temperature diffractometry, of the monoclinic-tetragonal phase changes in pure ZrO_2 and HfO_2 disclosed that the hysteresis loops associated with the transformations have similar shapes that are typical of many martensitic phase changes, but that the widths of the loops differ greatly for the two materials, being about 200°C for zirconia and only 20 to 30°C for hafnia. The temperature-induced transformations are predominantly athermal. The nature of these and similar transformations is discussed. The reversible formation of a cubic form of ZrO_2 above 2200°C was confirmed. (auth)

39560 ON THE QUESTION OF A PHASE CHANGE IN ZIRCONIUM MONOCARBIDE. Leonard N. Grossman (General Electric Co., Pleasanton, Calif.). J. Am. Ceram. Soc., 46: 457-8(Sept. 1963).

It is shown that changes in the spectral emittance of ZrC are due to the formation and decomposition of a reaction product layer on the carbide surface, formed from reaction with active gas in the experimental apparatus. Data on the electrical resistivity of ZrC at 1500 to 2850°K, in which no discontinuities were found, are presented. No evidence supporting the existence of a phase change in ZrC was found. (P.C.H.)

39561 WHAT ARE THE POTENTIALITIES OF BERYLLIUM-LIGHT-METAL ALLOYS? Donald Bodene (Beryllium Corp., [Reading, Penna.]). J. Metals, 15: 606-7(Sept. 1963).

A survey of beryllium as an additive to aluminum- and magnesium-base alloys is presented. Consideration is given to Be as an additive to Al-Si-Mg, Al-Cu, Al-Li, and Ti alloys, as well as additions to aluminum-dip coat baths. (auth)

39562 VANADIUM ALLOYS IN AEROSPACE. R. J. Van Thyne. J. Metals, 15: 642-4(Sept. 1963).

The potential of V alloys for applications above 2000°F is described. Mechanical properties are tabulated and reviewed, with major emphasis on the V-Nb alloys. Evaluations of fabricability are considered, and investigations of several oxidation-protection systems, particularly pack-siliconizing treatment are detailed. (auth)

39563 CREEP DEFORMATION OF NON-STOICHIOMETRIC URANIUM DIOXIDE. W. M. Armstrong and W. R. Irvine (Univ. of British Columbia, Vancouver). J. Nucl. Mater., 9: 121-7(July 1963). (In English)

Sintered uranium dioxide specimens in the composition range $UO_{2.00}$ to $UO_{2.25}$ were subjected to creep-in-bending tests at temperatures from 975 to 1400°C. The creep behavior of oxides in the composition range $UO_{2.02}$ to $UO_{2.08}$ could be represented by the relationship $\dot{\epsilon} = A\,(O/U - 2)\,\sigma \exp(-55700/RT)$, where $\dot{\epsilon}$ is the unit strain rate in response to a tensile stress σ, R is the gas constant, T the absolute temperature, and A a constant of proportionality. For O/U ratios higher than approximately 2.08, the stress exponent was larger than unity. Metallographic examination of test specimens revealed that grain boundary sliding occurs during creep of these materials. Also, the presence of excess oxygen inhibits the intercrystalline cracking which accompanies creep of stoichiometric uranium dioxide. (auth)

39564 THE U-Pu-C TERNARY PHASE DIAGRAM BELOW 50 ATOMIC PERCENT CARBON. S. Rosen, M. V. Nevitt, and J. J. Barker (Argonne National Lab., Ill.). J. Nucl. Mater., 9: 128-36(July 1963). (ANL-FGF-368; UAC-6745). (In English)

The U-Pu-C ternary phase diagram for the composition range from 0 to 50 at. % carbon and for temperatures below 635°C was constructed from metallographic, x-ray diffraction, and melting range data. Isothermal sections at 400, 570, and 635°C are presented and certain four phase reactions are outlined. Uranium monocarbide forms a complete series of solid solutions with plutonium monocarbide. All phase boundaries other than those of the monocarbide phase represent the sides of three-phase tie-triangles, which have one side coincident with either the U-Pu or the Pu-C binary side and have the opposite apex touching the phase boundary of the monocarbide solid solution, (U, Pu)C. The metal:carbon stoichiometry of the monocarbide is influenced by the U:Pu ratio. (auth)

39565 THE URANIUM MONOCARBIDE-PLUTONIUM MONOCARBIDE SYSTEM. S. Rosen, M. V. Nevitt, and

A. W. Mitchell (Argonne National Lab., Ill.). J. Nucl. Mater., 9: 137-42(July 1963). (ANL-FGF-369; UAC-6746). (In English)

The (U, Pu)C phase field of the U–Pu–C ternary system for temperatures below 635°C was constructed from metallographic and x-ray diffraction data. Uranium monocarbide forms a complete series of solid solutions with plutonium monocarbide. The (U, Pu)C phase is stoichiometric as regards its carbon content in a composition range from 0 to 35 at. % Pu. With a further increase in Pu content it deviates from ideal stoichiometry toward greater metal-to-carbon ratios to form the defect (U, Pu)C phase. Pu expands the unit cell of the monocarbide over the composition range in which it retains its stoichiometric character. In the region of the defect structure the lattice parameter decreases with increasing Pu content, the extent of the decrease being dependent upon the C content. Metallographic observations on cast alloys show that a transition in the microstructures occurs at about 10 at. % Pu. Alloys containing less Pu show a homogeneous carbide phase while alloys of higher Pu content have a cored carbide phase. (auth)

39566 THE KINETICS OF THE ISOTHERMAL DECOMPOSITION OF A GAMMA-PHASE URANIUM–6 ATOMIC % MOLYBDENUM ALLOY. B. W. Howlett (Atomic Energy Research Establishment, Harwell, Berks, Eng.), A. J. Eycott, I. K. Kang, and D. R. F. West. J. Nucl. Mater., 9: 143-54(July 1963). (AERE-R-4076). (In English)

The kinetics of the isothermal decomposition of a gamma-phase uranium–6 at. % molybdenum alloy were investigated over the temperature range 670 to 390°C. The techniques used in the study were dilatometry, metallography, hardness measurements, and x-ray diffraction. Special emphasis was placed on studying the early stages of decomposition. Four different decomposition modes were found; one of these, involving the formation of a fine granular structure, has not been reported before for alloys of similar composition. (auth)

39567 PURIFICATION OF URANIUM BY FLOATING ZONE REFINING BY ELECTRON BOMBARDMENT. Jacques Pascal and Paul Lacombe (Ecole des Mines, Paris). J. Nucl. Mater., 9: 155-69(July 1963). (In French)

A zone refining procedure was applied to uranium. However, since U presents some peculiarities, which prevent the straightforward application of the method in the way it has been used for classical metals such as iron, aluminium, and copper, the vertical zone-melting process, which involves the melting in vacuum of a liquid zone in a vertically placed cylindrical bar, was adopted. The zone is melted by electron bombardment. This type of heating offers the advantage, as opposed to induction-heating, of a constant input power stabilized by feedback. This favors the mechanical stability of the liquid zone and its transport along the bar without fluctuations of velocity (which are highly prejudicial to effective purification). The purification obtained by this procedure was tested by low temperature resistivity measurements and by experiments on secondary recrystallization following heavy deformation. This type of recrystallization never appears in uranium of normal reactor grade uranium because discontinuous growth of grains is inhibited by impurities. (P.C.H.)

39568 THERMAL EVAPORATION AND IMPURITIES OF COMMERCIAL BERYLLIUM BETWEEN 650 AND 1000°C. P. Bastien and P. Pointu (Ecole Centrale des Arts et Manufactures, Paris). J. Nucl. Mater., 9: 185-96(July 1963). (In French)

Thermal evaporation of single crystals of beryllium of commercial purity between 650 and 1000°C generates plane facets the indices of which were determined, and leaves in relief structures of threadlike form, containing a high percentage of transition elements, the orientation of which is related to that of the crystalline matrix. These structures were examined by electron microscope and by electron microprobe analysis. (auth)

39569 DIMENSIONAL CHANGES IN GRAPHITE: THE RELATIONSHIP BETWEEN THOSE PRODUCED BY ABSORPTION OF BROMINE AND THOSE PRODUCED BY IRRADIATION. J. E. Brocklehurst and J. C. Weeks (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). J. Nucl. Mater., 9: 197-210(July 1963). (In English)

A study of the macroscopic growth that occurs when graphite absorbs bromine was made to determine whether the bromination-induced dimensional changes could be related to those that occur in graphite under fast neutron irradiation. For a number of extruded graphites the initial growth per unit concentration of absorbed bromine is related to the linear thermal expansion coefficient of the original graphite sample, and this enables the crystallite changes on bromination in the c and a axial directions to be derived. Bromination causes large increases in the dimensions of the graphite crystallites in the c direction and is therefore able to close up the oriented microporosity which, in the initial stages of growth, partially absorbs the crystal strain in this direction. Irradiation growth also involves an increase in the dimensions of the crystallites in the c direction, and the amount of accommodation of strain in this direction by microporosity is important in determining the macroscopic growth behavior. The variation in the amount of accommodation of crystal strain as the oriented microporosity is closed up by absorption of bromine was determined and expressed in a manner that provides a basis for comparing different graphites and enables a comparison to be made with similar data from the irradiation work. There is good agreement between the bromination and irradiation data up to a crystal strain in the c direction of about 8%; above this level, the discrepancies are believed to result from an assumption made in interpreting the irradiation results, namely that the thermal expansion coefficients of the crystallites in the c and a directions are unchanged by irradiation. (P.C.H.)

39570 RADIATION-INDUCED PHASE CHANGE AND RECOVERY IN ZrO_2. J. Adam and M. D. Rogers (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 9: 211-12(July 1963). (In English)

Thick but adherent films of oxide were produced on Zr–5 wt % V alloy discs in an autoclave at 300°C and the oxidized specimens were irradiated to different doses by fission fragments emitted from a thin film of U^{235} placed in vacuum at a distance of 2 mm from the samples. X-ray diffraction patterns obtained before and after irradiations indicate that the original monoclinic oxide changes into the cubic form, which is characteristic of zirconia when alloyed with certain elements. A sample was held for two hours at various temperatures up to 1000°C to study the thermal recovery of the irradiated specimens. A fairly sharp annealing peak was observed at 770°C. However, in specimens annealed up to 1000°C only about 50% of the transformed cubic phase reverted to the monoclinic form. (P.C.H.)

39571 POST IRRADIATION ANNEALING OF URANIUM–MOLYBDENUM TERNARY ALLOYS. D. Kramer and W. V. Johnston (North American Aviation Inc., Canoga Park, Calif.). J. Nucl. Mater., 9: 213-15(July 1963). (In English)

The effects of post-irradiation annealing on density changes in U–Mo alloys were investigated. Density changes that occurred in all the alloys studied during irradiation were accounted for by the solid fission products produced. No further density changes took place in the ternary systems studied (U–Mo–Si and U–Mo–Sn) when annealed at 650 and 550°C. However control samples (U–4 wt % Mo and U–10 wt % Mo) did undergo swelling with a density change of 11 and 2.3%, respectively. (P.C.H.)

39572 THERMAL EXPANSION OF GRAPHITE OVER DIFFERENT TEMPERATURE RANGES. W. H. Martin and F. Entwisle (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). J. Nucl. Mater., 10: 1-7(Sept. 1963). (TRG-Report-357) (In English)

An elastic model relating the bulk thermal expansion of polycrystalline graphite to that of the constituent crystals predicted a linear relationship between the thermal expansion coefficients of well-graphitized materials measured over different temperature ranges. Measurements on several different graphites over three temperature ranges show that this prediction is in reasonable agreement with experimental data. Crystal thermal expansion coefficients at temperatures in the range 100 to 700°C were determined from correlations of bulk expansions, assuming mean crystal thermal expansion coefficients over the temperature range. The crystal data are in reasonable agreement with measurements and calculations previously reported. (auth)

39573 EQUILIBRIUM IN OXYGENATED COMPOUNDS OF URANIUM AT 1500–2000°K. A. M. Anthony (CNRS, Paris), R. Kiyoura, and T. Sata. J. Nucl. Mater., 10: 8-14 (Sept. 1963). (In French)

The phase diagram of the oxygenated compounds of uranium was established for temperatures in the range 1500–2000°K. The method used involved quenching uranium oxide samples held at a fixed temperature and known partial pressure of oxygen. Measurements by means of a thermobalance allowed the O/U ratio to be determined, while x-ray examination established the number of phases present. Three regions were found: a single-phase region, a solution of oxygen in UO_2; a two-phase region in the range $UO_{(2+x)}$–$UO_{2.61}$, and a homogeneous region in the range $UO_{2.61}$–U_3O_8. Thermodynamic functions were computed and compared with previously published values. (auth)

39574 SECONDARY RECRYSTALLIZATION AND RECRYSTALLIZATION AFTER CRITICAL COLD WORKING OF HIGH PURITY URANIUM. Nelly Ambrosis de Libanati, Daniel Calais, and Paul Lacombe (Centre de Recherches Métallurgiques de l'Ecole des Mines, Paris). J. Nucl. Mater., 10: 23-42(Sept. 1963). (In French)

The growth of large grains, either by secondary recrystallization after deformation by heavy rolling and prolonged annealing at high temperatures in the α phase, or by critical straining and annealing applied to a primary recrystallization texture, was observed in electrolytic uranium of high-purity. Only uranium of high purity undergoes these two types of exaggerated grain growth. Thus, these two methods of growth provide then a very secure qualitative criterion of the purity of the uranium. The crystalline orientation of a very large number of grains formed by the two methods of growth were determined by Laue back-reflection diagram. The crystals of secondary recrystallization possess a texture very much more pronounced than that displayed by the crystals produced by critical straining. However, in the two cases, it is remarkable that the b axis of all the crystals seems to play an important role in the growth since it is always oriented essentially parallel to the direction of rolling. It is only when a deformation is applied to the primary recrystallization texture, considerably in excess of the critical deformation that growth during further annealing of crystals having some very diverse orientations is observed. An attempt was made to explain these two modes of growth, by secondary recrystallization or by critical strain, by relating the deformation texture obtained on heavy deformation to the textures either of secondary recrystallization or of recrystallization after critical strain. (P.C.H.)

39575 URANIUM NITRIDES. P. E. Evans and T. J. Davies (Univ. of Manchester, Eng.). J. Nucl. Mater., 10: 43-55(Sept. 1963). (In English)

The structure of uranium nitrides and on the preparation of the mononitride is reviewed. The mononitride was prepared as a finely divided uncontaminated powder by hydriding uranium turnings, decomposing the hydride, forming higher nitrides, and reducing them to the mononitride. The sesquinitride was found to be body-centered cubic and the mononitride face-centered cubic. Dissociation occurs when the mononitride is heated to excessive temperatures in vacuo or in an argon atmosphere, but in a nitrogen atmosphere the formation of higher nitrides precedes dissociation. Density and microhardness were measured. (auth)

39576 POSSIBILITY OF THE APPEARANCE OF THE LIQUID PHASE BEGINNING WITH 430°C IN COMMERCIAL BERYLLIUM. M. Weisz, J. Mallen, and J. L. Baron (Centre d'Etudes Nucléaires, Saclay, France). J. Nucl. Mater., 10: 56-9(Sept. 1963). (In French)

Studies were made on a synthetic Al–Be–Si alloy with 10% Al and 3% Si in order to determine the temperature of the appearance of the liquid phase in the grain boundaries in commercial Be. The fusion point of the eutectic was found by x-ray diffraction. The diffraction chamber used permitted the sample to be heated in a sub-vacuum. A Debye-Scherrer diagram raised to the ambient temperature showed the lines (511-333) and (422) of Al and some spots due to the large crystal of the Be matrix. When the temperature was raised to 460°C, the lines disappeared. This indicates that at 460°C it is in the liquid stage. In the course of chilling it is even to 430°C and below that the intense lines of Al reappear. Thus the temperature of solidification of the ternary eutectic of Al–Be–Si is between 440 and 430°C. (P.C.H.)

39577 MICROSCOPIC EXAMINATION OF BERYLLIUM IN THE COURSE OF DEFORMATION IN THE DOMAIN OF HOT BRITTLENESS. P. Bastien and P. Pointu (Ecole Centrale des Arts et Manufactures, Paris). J. Nucl. Mater., 10: 63-6(Sept. 1963). (In French)

During a microscopic examination of the polished surface of a cylindrical plate during traction, studies were made on the behavior of 2 variations of commercial Be between ambient temperature and 900°C before and after precipitation for 110 hr. One specimen, A, showed a ratio Al/Fe in weight of 3.5 while a second specimen, B, had a ratio of 0.67. After annealing from precipitation, sample A always showed the liquid phase above 500°C, contrary to sample B. The liquid phase appeared then as the cause of hot brittleness. Independent of the liquid phase and of the decohesion of joints, the intragranular deformation of the raw metal showed some bands of great slip and spaces between 150 and 300°C. Other deformation characteristics are also described. (P.C.H.)

39578 ANNEALING FRIABILITY OF CONSTRUCTION STEEL WITH LANTHANUM ADMIXTURES. M. M. Shteinberg, V. A. Mirmel'shtein, and E. S. Kodes (Ural Polytechnic Inst., USSR). Metalloved. i Term. Obrabotka Metal., No. 8, 6-10(Aug. 1963). (In Russian)

Optimum friability annealing was reached with 0.15 to 0.23% La admixtures to KhLN steel and 0.26 to 0.30% La to 30KhGS steel. Admixtures of La are more effective than Mo in preventing intergrain disintegration. (R.V.J.)

39579 EFFECTS OF CERIUM ON MECHANICAL PROPERTIES OF STEEL 15KhIM1F. N. S. Kreshchanovskii, V. R. Nazarenko, and G. A. Ryzhkova (Central Research Inst. of Tech., USSR). Metalloved. i Term. Obrabotka Metal., No. 8, 23-7(Aug. 1963). (In Russian)

It was shown that cerium admixtures improved mechanical properties of 15 KhIM1F steel. The best effects were reached with 0.1 to 0.15% Ce introduced at 1500 to 1590°C and followed with soaking for not over 25 min. (R.V.J.)

39580 FINE STRUCTURE OF RARE-EARTH-ALLOYED XN77TYu STEEL. T. V. Svistunova and G. V. Estulin. Metalloved. i Term. Obrabotka Metal., No. 8, 27-33(Aug. 1963). (In Russian)

X-ray diffraction, internal friction, and diffusion analyses indicated that small admixtures of Ce, La, and Nd refine the intragrain structure of chromium steel (KhH77TYu), contract intergrain boundaries, and reduce boundary and volume diffusion of chromium. (R.V.J.)

39581 RARE EARTH ALLOYS. V. F. Terekhova (Baikov Inst. of Metallurgy, USSR). Metalloved. i Term. Obrabotka Metal., No. 8, 47-53(Aug. 1963). (In Russian)

Physical and mechanical properties of rare earth alloys and various metals alloyed with rare earths were studied. Phase diagrams were constructed and analytical data are given for Mg–Nd, Mg–Y, Mg–Gd, Al–Nd, Al–Y, La–Ce, Pr–Nd, Gd–Ce, Sn–Y, Cr–La, Cr–Ce, and Cr–Y alloys. (R.V.J.)

39582 PROPERTIES OF 35 GL STEEL WITH RARE EARTH AND BORON ADMIXTURES. V. N. Polisadov (Moscow Inst. of Metallurgy). Metalloved. i Term. Obrabotka Metal., No. 8, 54-5(Aug. 1963). (In Russian)

Effects of rare earths and boron on manganese steel (60 to 65% Mn, 11 to 16% Si, and 6 to 7% Al), and low alloyed oxidized industrial steel (35 GL) were studied. It is shown that rare earths produce a favorable effect on plastic deformation and shock ductility in cast steel (0.32 to 0.35% C, 0.30 to 0.35% Si, 1.30 to 1.44% Mn, 0.04 to 0.05% P, and 0.04 to 0.05% S) and to a lesser degree in deformed steel. Rare earths facilitate elimination of sulfur and better distribution of the remaining sulfur. Admixtures of 1.6 kg of boron per ton of steel do not influence the mechanical properties of 35 GL steel, however, the annealing properties are much improved. (R.V.J.)

39583 EFFECTS OF RARE EARTHS AND THEIR OXIDES ON CERTAIN PROPERTIES OF STAINLESS STEEL. T. M. Bobkov, E. M. Moshkevich, K. P. Gunaza, and V. I. Zlatkin, (Dnepr Factory of Special Steel, USSR). Metalloved. i Term. Obrabotka Metal., No. 8, 55-9(Aug. 1963). (In Russian)

Effects of rare earths and their oxides on stainless steel ductility at high temperatures and mechanical properties at room temperature were studied. Admixtures of 0.05 to 0.30% FeCe, 0.05 to 0.25% La, 0.05 to 0.4% CeO_2, 0.05 to 0.4% lanthanum oxide, and 0.05 to 0.3% praseodymium oxide did not improve ductility in the examined steel. (R.V.J.)

39584 CHEMICAL HETEROGENEITY OF CONSTRUCTION AND STAINLESS STEELS TREATED WITH RARE EARTHS. V. F. Popov and E. M. Savitskii (Baikov Inst. of Metallurgy, USSR). Metalloved. i Term. Obrabotka Metal., No. 8, 59-61(Aug. 1963). (In Russian)

Admixtures of 0.1 to 0.28% ferrocerium to oxidized steel reduced the sulfur content by 20%. Additions of 0.1% of rare earths did not effect the content of sulfur or carbon in stainless steel (Kh18N12M2T). In construction steels (30 KhGSA and 18 KhNVA) the removal of sulfur is proportional to the addition of rare earths. (R.V.J.)

39585 BERYLLIUM AND ITS ALLOYS. A. V. Francis. Metallurgie (Paris), 95: 529-31; 533; 535; 537; 539; 541; 543(May 1963). (In French)

A review is presented on the mechanical and physical properties, crystal structure, and corrosion resistance of Be and its alloys. Parameters for ore extraction, purifying, heat treatment and forming processes are also included. (Rev. Metal Lit., 20: No. 9, Sept. 1963)

39586 INVESTIGATION OF THE SYSTEMS THORIUM–MOLYBDENUM–CARBON AND URANIUM–MOLYBDENUM–CARBON. E. Rudy and F. Benesovsky. Monatsh. Chem., 94: 85-97(1963). (In German)

X-ray and metallographic analysis was made of phase equilibria at 900 to 1600°C in the ternary systems Th–Mo–C and U–Mo–C using pressure-sintered, vacuum-annealed, and arc melted specimens. Representation of the respective phase diagrams in terms of isothermal sections are given. (Rev. Metal Lit., 20: No. 9, Sept. 1963)

39587 THE CRYSTAL TYPES ScZn AND ScCd. E. Laube and H. Nowotny. Monatsh. Chem., 94: 162-3 (1963). (In German)

Specimens of ScZn and ScCd were prepared by sintering of powder mixtures at 600 to 700°C using Ar as protective atmosphere. The lattice parameters of the formed crystalline phases were studied by x-ray analysis. (TCO)

39588 THE KNOWLEDGE OF THE STABILITY OF THE URANIUM CARBIDE AND THE CARBON-STABLE REGIONS IN THE PARTIAL SYSTEMS OF UC WITH ZrC, HfC, NbC AND TaC. E. Rudy and F. Benesovsky. Monatsh. Chem., 94: 204-24(1963). (In German)

X-ray analysis was made of phase equilibra in the ternary systems UC–ZrC–C, ZUC–HfC–C, UC–NbC–C, and UC–TaC–C using pressure-sintered, vacuum sintered, and homogenized specimens. The standard free energy functions for the decomposition of the uranium carbides were evaluated. (Rev. Metal Lit., 20: No. 9, Sept. 1963)

39589 ADSORPTION OF KRYPTON AND XENON ON EVAPORATED METAL FILMS IN RELATION TO THE DETERMINATION OF SURFACE AREA AND THE NATURE OF ADSORBED CARBON MONOXIDE. D. Brennan, M. J. Graham, and F. H. Hayes (Univ. of Liverpool). Nature, 199: 1152-4(Sept. 21, 1963).

An investigation was made on the value of the ratio $\sigma(Xe)/\sigma(Kr)$ determined for evaporated films of Ti, Zr, Fe, Co, Ni, Mo, W, Ta, and Pt at 77°K. The procedure followed in every case was to obtain successively the adsorption isotherm for Xe, Kr, and then Xe again, on the same film with the complete removal of adsorbate prior to each determination. It was concluded that, in general, the effective areas of Kr and Xe atoms on the metals are virtually the same. Apart from Zr, which has the largest lattice spacings, there is no likelihood of adsorbing more Kr atoms than Xe atoms on the metals, and, even for Zr, the possibility of doing so is not strong. (P.C.H.)

39590 TWINNING AT 77°K OF "FLASH-ANNEALED" NIOBIUM. A. Fourdeux and A. Wronski (Union Carbide European Research Associates, Brussels). Nature, 199: 1284-5(Sept. 28, 1963).

Using a flash-annealing technique, the proportional limit of niobium foils strained at 1% per min was lowered to

~3.5 kg mm^{-2}. This material was strained at 77°K. Proportional limit was sometimes found to be ~50 kg mm^{-2}, but twinning occurred before and/or after this stress value. Twinning sometimes commenced at a stress level of ~20 kg mm^{-2}. Maximum tensile stress was sometimes only a little higher than 50 kg mm^{-2}, but with other specimens profuse twinning continued for appreciable extension. (M.C.G.)

39591 VARIATIONS IN ORIENTATION OF ETCH PITS ON GRAPHITE SURFACES. J. M. Thomas, E. E. Glenda Hughes, and B. R. Williams (University Coll. of North Wales, Bangor, Eng.). Phil. Mag. (8), 8: 1513-18(Sept. 1963).

A study was made of the dependence of etch-pit shape upon oxidizing temperature for oxygen and for nitric oxide. For nitric oxide it was established that, at 873°C, rates of oxidation in $(10\bar{1}0)$ and in $(11\bar{2}0)$ directions are comparable since dodecagonal pits are obtained on the {0001} surfaces. Below and above this temperature the etch pits are hexagonal, being respectively parallel and perpendicular to the twin lamellae (sides of pits are in $(10\bar{1}0)$ and $(11\bar{2}0)$ directions respectively). For oxygen parallel and perpendicular pits were also observed, and the temperature at which the rates of oxidation in $(10\bar{1}0)$ and in $(11\bar{2}0)$ directions are comparable lies beyond 900°C. (auth)

39592 THE DEFORMATION OF GRAPHITE CRYSTALS AND THE PRODUCTION OF THE RHOMBOHEDRAL FORM. E. J. Freise and A. Kelly (Cambridge Univ., Eng.). Phil. Mag. (8), 8: 1519-33(Sept. 1963).

Natural graphite single crystals and polycrystals were deformed at room temperature and optical and electron microscope studies of these were coupled with x ray investigations. The appearance and disappearance of x-ray diffraction peaks corresponding to the rhombohedral structure were investigated. After plastic shearing the graphite crystals contain many tilt and twist boundaries and are profusely twinned. A mechanism is proposed for the production of the rhombohedral form. (auth)

39593 INDEPENDENT SLIP SYSTEMS IN CsCl-TYPE CRYSTALS. S. M. Copley (Univ. of California, Berkeley). Phil. Mag. (8), 8: 1599(Sept. 1963). (UCRL-10918)

A correction is given for a paper published previously on the slip systems in simple ceramic materials. Groves and Kelly (1963) stated that the slip systems in CsCl-type crystals were the {110} (010). This incorrect quote from Rachinger and Cottrell (1956) should have been {110} (001). (R.E.U.)

39594 SUPERCONDUCTIVITY OF SOME NEW Pt-METAL COMPOUNDS. Ch. J. Raub, W. H. Zachariasen, T. H. Geballe, and B. T. Matthias (Univ. of California, La Jolla). Phys. Chem. Solids, 24: 1093-1100(Sept. 1963). (In English)

Several new superconductors were discovered among compounds between Pt-metals and elements of the IV A, V A, and VI A group of the periodic system. The position of the elements in the periodic system, the valence electron concentration, and the crystallographic structure exhibit a strong influence on the superconducting behavior. (auth)

39595 THE VARIATION OF PERIODICITY OF MAGNETIC STRUCTURE WITH DILUTION AND TEMPERATURE FOR THE HEAVY RARE EARTH METALS. B. R. Cooper (Harvard Univ., Cambridge, Mass.). Phys. Letters, 6: 19-21(Aug. 15, 1963). (In English)

Several possible mechanisms proposed to account for the variation of periodicity of magnetic structure with dilution and temperature for Tb, Dy, Er, Tm, and Ho are discussed. It is proposed that the best explanation for the observed magnetic structures seems to lie in having terms in the energy linking three or four localized f shells, that is, terms in which the conduction electrons linking two given sites scatter off one or more intervening sites. (C.E.S.)

39596 EINSTEIN SPECIFIC HEATS BELOW 1°K IN SOME Fe–V ALLOYS. R. G. Scurlock and E. M. Wray (Univ. of Southampton, Eng.). Phys. Letters, 6: 28-9 (Aug. 15, 1963). (In English)

The specific heats of three Fe–V alloys were measured. The alloys contained 69, 74, and 78 at. % vanadium, and measurements were made between 0.4 and 4°K in a He^3 cryostat. The 69 and 74 at.% alloys show an Einstein specific heat with different values of the Einstein temperature that are very much larger than previously predicted values. The specific heat terms of these two alloys increase with temperature to an approximately constant value above 1°K. It was proposed that these specific heat terms are related to the onset of ferromagnetism in the alloys. (C.E.S.)

39597 RENORMALISATION EFFECT IN THE ELECTRONIC SPECIFIC HEAT OF VANADIUM. K. Krebs (Euratom C.C.R., Ispra, Italy). Phys. Letters, 6: 31-3(Aug. 15, 1963). (In English)

The lattice vibrational spectrum of vanadium calculated from the differential inelastic scattering cross section for slow neutrons is presented. The lattice specific heat and corresponding Debye temperatures are shown. The lattice specific heat above 150°K derived from neutron data is compared with caloric measurements, and it is found that the electronic specific heat constant found at low temperature is not valid at higher temperatures. It is proposed that this effect might be attributed to the renormalization of the free energy of electrons, which is caused by the electron-phonon interaction. To give a qualitative justification of this proposal the expression for the free energy of the electrons was evaluated. (C.E.S.)

39598 THERMAL CONDUCTIVITY OF NIOBIUM–ZIRCONIUM ALLOYS AT LOW TEMPERATURES. P. Radhakrishna and M. Nielsen (Research Establishment, Risö, Denmark). Phys. Letters, 6: 36-8(Aug. 15, 1963). (In English)

The thermal conductivity of alloys of niobium containing 0.2 and 2% of zirconium in the normal and superconducting states between 1.6 and 12°K was investigated to determine the effect of impurities. The smoothed values of the thermal conductivity in the normal and superconducting states were plotted against temperature. The normal state conductivity could be accounted for by electron scattering by point defects. The electron and phonon contributions to the specific heat in the superconducting state were calculated and at the lowest temperatures the specific heat, due primarily to phonons, was proportional to the square of the temperature as would be expected if the scattering were limited by dislocations. (C.E.S.)

39599 NUCLEAR MAGNETIC RESONANCE IN FERROMAGNETIC Mn_5Ge_3 AT LOW TEMPERATURES. R. F. Jackson (Univ. of Southampton, Eng.), R. G. Scurlock, D. B. Utton, T. H. Wilmshurst, and M. Rubinstein. Phys. Letters, 6: 39-40(Aug. 15, 1963). (In English)

The enhanced nuclear magnetic resonance of Mn^{55} in ferromagnetic Mn_5Ge_3 was investigated at 1.6, 4.2, and 77.0°K. A negative frequency shift of the 216.6 Mc line at 1.6°K was found, suggesting that the effective nuclear field is negative for Mn at the 4d site. Measurements on spin-lattice relaxation times made by observing the recovery

of the spin-echo signal after saturation were also presented. (C.E.S.)

39600 THERMAL CONDUCTIVITY OF NIOBIUM FROM 1.6°K TO 15°K. T. Amundsen and T. Olsen (Universitetet, Oslo). Phys. Norvegica, 1: 167-71(1963). (In English)

The thermal conductivity of niobium was measured in the range 1.6 to 15°K. Around the transition temperature (T_c), the main part of the heat was carried by the electrons, and the observed thermal conductivity in the superconducting phase was found to be in good agreement with a previous theory. Below T = 2.5°K the thermal conductivity was dominated by the lattice contribution, and the data gave information about the dislocation density. A small lattice contribution to the total thermal conductivity above T_c was established. (auth)

39601 A STUDY OF THE CRYSTAL DYNAMICS OF ZINC. G. Borgonovi, G. Caglioti, and J. J. Antal (Comitato Nazionale per l'Energia Nucleare, Ispra, Italy). Phys. Rev., 132: 683-8(Oct. 15, 1963).

A number of the normal modes of vibration of the anisotropic hexagonal metallic system of zinc were studied through a determination of the dispersion relations by neutron inelastic scattering. Measurements carrying relatively small experimental errors were made for directions in a single crystal that produce information about the motions of atoms within the basal planes, the motion of the basal planes acting as single units, and the motions of atoms perpendicular to the basal planes that tend to warp these planes. Attempts are made to fit the experimental data to formulations of Born-von Kármán dynamical theory involving generalized forces between pairs of atoms. Consideration of forces extending to fourth nearest neighbors is necessary to obtain agreement with our dispersion relations. The experimental data generally supply details of the anisotropic mechanisms operating in zinc and indicate that anomalies might exist in the dispersion relations describing atomic motions perpendicular to the basal planes. (auth)

39602 THE DETERMINATION OF THE TYPE OF STACKING FAULTS IN FACE CENTERED CUBIC ALLOYS BY MEANS OF CONTRAST EFFECTS IN THE ELECTRON MICROSCOPE. A. Art, R. Gevers, and S. Amelinckx (S.C.K.-C.E.N., Mol, Belg.). Phys. Status Solidi, 3: 697-711(1963). (BLG-187). (In English)

A practical method is described for the determination of the nature of stacking faults in face centered cubic structures. The method involves a comparison of the bright and dark field image of the fringe pattern associated with a stacking fault lying in an inclined plane. A complete analytical derivation of the principles of the method is given, and it is used to show that stacking faults in a copper–15% gallium alloy are of the intrinsic type. (auth)

39603 THE RUTHERFORD MEMORIAL LECTURE, 1962. ATOMIC PHYSICS AND THE STRENGTH OF METALS. Nevill Mott. Proc. Roy. Soc. (London), Ser. A, 275: 149-60(Sept. 24, 1963).

The history and present status of the concept of dislocations in crystals are reviewed. Emphasis is placed on the questions of why are metals ductile and why are alloys more resistant to deformation. An explanation in terms of movements of atoms is given. (R.E.U.)

39604 DIFFUSION OF Pu IN UO_2. F. Schmitz and R. Lindner (CCR Euratom, Ispra, Italy and Technical Univ., Braunschweig, Ger.). Radiochim. Acta, 1: 218-20(Aug. 1963). (In English)

The diffusion of Pu^{239} in sintered pellets of UO_2 (density 10.6) was measured with the methods of α radiation absorption and sectioning. The temperature dependence of the diffusion coefficient is represented by the equation: $D = 0.34 \exp(-97300 + 4100/RT)$ cm^2 sec^{-1}. Comparison was made with the self-diffusion of Uranium by a new technique of differential diffusion measurements. It results that the activation energy for Plutonium diffusion is 6.0 kcals less than that of uranium diffusion. (auth)

39605 EMISSION-ELECTRON MICROSCOPIC INVESTIGATION OF THE BETA–ALPHA TRANSFORMATION OF ZIRCALOY-2 IN REPEATED TEMPERATURE CYCLES. W. Epprecht, E. B. Bas, and R. Aeschlimann. Schweiz. Arch. Angew. Wiss. Tech., 29: 181-5(May 1963). (In German)

After an electron microscopic investigation of the beta–alpha phase transformation in Zircaloy-2 during repeated temperature cycling at 500 to 1100°C, an analysis was made of slip-lamellae, which formed as a result of anisotropic thermal expansion. (Rev. Metal Lit., 20: No. 9, Sept. 1963)

39606 HELICAL STRUCTURES OF THE HEAVY RARE EARTH METALS. P. G. De Gennes (Faculté des Sciences, Orsay, France) and D. Saint-James. Solid State Commun., 1: 62-6(Aug. 1963). (In English)

The interlayer turn angle ω_1 is calculated for the heavy rare earth metals at their upper transition point, taking into account the effect of a finite mean free path on the Ruderman-Kittel interaction. The theoretical value of ω_1 increases with the mean free path from 0° for Gd to 53° for Tm, which is in rough agreement with the neutron-diffraction results. (auth)

39607 INFLUENCE OF RARE EARTH METALS ON PROPERTIES OF Cr–Ni STEEL. Ya. E. Gol'dshtein, V. I. Zel'dovich, A. I. Komissarov, and E. L. Korotkevich. Stal', No. 4, 354-8(1963). (In Russian)

Steel (40KhN) was alloyed in a ladle by addition of ferrocerium in quantities from 0.1 to 0.6%. After alloying, the steel was normalized, quenched, tempered, and tested to determine the effect of the additions and of tempering temperature on hardenability, temper brittleness, cold shortness, yield point, tensile strength, resilience, plasticity, and grain size. (Rev. Metal Lit., 20: No. 9, Sept. 1963)

39608 DIFFUSION IN THE URANIUM–NIOBIUM (COLUMBIUM) SYSTEM. N. L. Peterson (Argonne National Lab., Ill.) and R. E. Ogilvie. Trans. AIME, 227: 1083-7 (Oct. 1963).

Diffusion measurements were conducted at all compositions in the bcc solid solution of the U–Nb system employing incremental couples at composition intervals of 10 at. %. Diffusion coefficients were determined by the Matano method from concentration gradients obtained with the electron-probe microanalyzer. The activation energy for interdiffusion as a function of composition shows three distinct regions: 80 to 100% U, $\tilde{Q} \approx 30$ kcal per mole; 20 to 80% U, $\tilde{Q} \approx 70$ kcal per mole; and 0 to 20% U, $\tilde{Q} \approx 140$ kcal per mole. The frequency factor, $\tilde{D}_0$ and the activation energy $\tilde{Q}$ were found to be roughly related by the equation $\log \tilde{D}_0 = 9.7 \times 10^{-5} \tilde{Q} - 6.6$. The Kirkendall marker movement indicates that D_U is larger than D_{Nb} between 16 and 100% U and D_{Nb} is larger than D_U from 0 to 4% U. (auth)

39609 THERMODYNAMICS OF INTERSTITIAL SOLID SOLUTIONS WITH REPULSIVE SOLUTE-SOLUTE INTERACTIONS. Kenneth A. Moon (Army Materials Research Agency, Watertown, Mass.). Trans. AIME, 227: 1116-22 (Oct. 1963).

An exact statistical treatment of a one-dimensional

model is used as a basis for evaluating the reliability of certain simplified expressions for the activity of the solute in interstitial solutions, including one obtained from the exact expression by setting the repulsive interaction equal to infinity. The latter approximation was found to be satisfactory at low and moderate concentration if the repulsive interaction is large, even though not infinite. A similar expression (identical if the coordination number is two) was derived from the quasichemical expression of Lacher, and is recommended as the best available expression for the excess configurational entropy of interstitial solutions with excluded sites. Some reasonable models are discussed, and the nature of the saturated solutions is determined by inspection. Some of the models reduce to the one-dimensional case. An analysis is given of the excess partial entropy of hydrogen in V–H, Nb–H, and Ta–H solutions. (auth)

39610 TRANSMISSION ELECTRON MICROSCOPY OF COLD-WORKED AND RECRYSTALLIZED ALPHA URANIUM. Dana L. Douglass and S. E. Bronisz (Los Alamos Scientific Lab., N. Mex.). Trans. AIME, 227: 1151-5(Oct. 1963). (LADC-5655)

α Uranium was deformed by cold rolling, and the effects of the plastic deformation on the microstructure of the metal were observed by the technique of transmission electron microscopy. The recrystallization of selected cold-worked samples was also studied by this method. The samples were prepared for examination by electrolytic thinning in a standard metallographic electrolyte, which has not been previously reported as being used in producing thin foils of uranium. The microstructural changes observed in the α uranium were generally similar to those seen by optical microscopy. (auth)

39611 EFFECT OF INTERSTITIAL ELEMENTS ON TWINNING IN COLUMBIUM. C. J. McHargue and H. E. McCoy (Oak Ridge National Lab., Tenn.). Trans. AIME, 227: 1170-4(Oct. 1963).

Single crystals of Nb containing various levels of oxygen, nitrogen, carbon, or hydrogen were deformed by slow compression and impact loading at –196°C. For the slow deformation rates, 1500 to 1900 ppm oxygen, 500 ppm nitrogen, or 150 to 200 ppm carbon completely suppressed mechanical twinning. Hydrogen in concentrations to 1000 ppm had no apparent effect on ease of twinning. Impact loading caused twins to form at all levels of contamination studied, and cleavage cracking on {100} planes occurred in specimens having higher interstitial contents. (auth)

39612 THE SURFACE TENSION OF LIQUID TRANSITION METALS AT THEIR MELTING POINTS. B. C. Allen (Battelle Memorial Inst., Columbus, Ohio). Trans. AIME, 227: 1175-83(Oct. 1963).

Liquid surface tensions of copper and 18 Group IV-A to VIII transition metals (Ti, Zr, Hf, V, Nb, Ta, Mo, W, Re, Ru, Rh, Pd, Os, Ir, Pt, Fe, Ni, Co) were measured by the static pendant-drop and dynamic drop-weight methods on the same rod sample. The drops were formed by electron-bombardment heating in high vacuum. Application of necessary corrections enabled determination of surface tensions to ±2% and agreement between methods to ±1 to 4% for all the metals studied. Evidence is presented that the liquid surface was well screened by metal vapor, suggesting negligible adsorption of gaseous impurities and that the surface tensions measured are characteristic of the metals involved. Correlations between liquid surface tension and melting point, molar volume, heat of vaporization, and atomic number are presented and discussed. Temperature coefficients of surface tension were calculated using Eötvös' law. (auth)

39613 OXIDATION OF SINGLE-CRYSTAL AND POLYCRYSTALLINE ZIRCONIUM. T. L. Mackay (Atomics International, Canoga Park, Calif.). Trans. AIME, 227: 1184-7(Oct. 1963).

Oxidation rates of single-crystal and polycrystalline zirconium in oxygen at temperatures from 307 to 815°C obey the parabolic rate law for short exposure time, 4 to 6 hr. The activation energy for the oxidation of single-crystal zirconium between 420 and 790°C is 42.6 ± 0.7 kcal per mole, and in the temperature range 307 to 600°C the activation energy for oxidation of polycrystalline zirconium is approximately the same. The high-activation energy is indicative that diffusion through the bulk oxide film is the primary mode of mass transport for both types of metal. The higher oxidation rates for polycrystalline zirconium in this temperature range were attributed to differences in the orientation of the grains in the metal with respect to the oxidizing surfaces. Above 600°C, grain growth was observed in polycrystalline zirconium, and the oxidation rates approached those of single-crystal zirconium. (auth)

39614 A STUDY OF THE ALUMINUM–LITHIUM SYSTEM BETWEEN ALUMINUM AND Al–Li. E. D. Levine and E. J. Rapperport (Kennecott Copper Corp., Lexington, Mass.). Trans. AIME, 227: 1204-8(Oct. 1963).

The boundaries of the ($\alpha + \beta$) field in the Al–Li system were determined between 150 and 550°C utilizing quantitative metallography and lattice-parameter measurements. The solubility of lithium in aluminum decreases from 12.0 at. % Li at 550°C to 5.5 at. % Li at 150°C. β Al–Li is saturated with aluminum at 45.8 at. % Li and has this boundary value constant over the temperature range 150 to 550°C. (auth)

39615 CLUSTERING EFFECTS IN SUPERCONDUCTING ALUMINUM–ZINC ALLOYS. C. Chiou and D. P. Seraphim (International Business Machines Corp., Yorktown Heights, N. Y.). Trans. AIME, 227: 1209-11(Oct. 1963).

The effect of clustering on the superconducting properties of Al–Zn alloys was studied by the ballistic induction techniques. The superconducting critical temperature, T_c, changes when zinc-rich clusters are formed. The change in T_c depends on the concentration and may be positive or negative, but always correlates with an effective decrease in the solute concentration of the alloy. Reversion after clustering effectively returns a 5 at. % Zn alloy to the quenched state. (auth)

39616 SOME MODIFICATIONS IN THE DIAGRAM FOR THE TANTALUM–ZIRCONIUM SYSTEM. L. F. Pease (Massachusetts Inst. of Tech., Cambridge) and J. H. Brophy. Trans. AIME, 227: 1245-9(Oct. 1963).

A phase diagram for the Ta–Zr system is presented. The system is of the minimum-melting point type with the β-zirconium phase decomposing monotectoidally at 785°C and 95.5 at. % Zr. The minimum solidus temperature is 1875°C and the temperature of the top of the monotectoid loop is 1775°C. Techniques employed included x-ray diffraction and fluorescence, electron microprobe analyses, diffusion couples, metallography, and melting-point measurements. Errors due to interstitial solutes and in melting observations are particularly common in this system, and their occurrence is discussed. (auth)

39617 INVESTIGATION OF SINTERED ALLOYS OF A ZrC–TaC SYSTEM. V. S. Dergunova, Yu. G. Kolonin, and V. Z. Tseytlin. Tsvetn. Metal., No. 6, 58-63(1963).

Eleven ZrC–TaC alloys, ranging from pure ZrC to pure

TaC, were investigated. Mixtures of 90.13%-pure Ta, 96.0%-pure Zr, and C were compacted, sintered in hydrogen at 1400 to 2400°C, crushed, and hot compacted in graphite dies at 2600 to 2700°C under a pressure of 230 kg/cm. Alloys were then annealed at 2300°C for 2 hr. X-ray diffraction patterns showed that the lattice parameter increased linearly from 4.440 Å for pure ZrC to 4.680 Å for pure TaC, indicating the unlimited solid solubility of the components. Microscopic examination also revealed only one phase in all alloys studied. Specific density increased continuously with increasing TaC content. Microhardness at room temperature decreased continuously from approximately 2170 kg/mm for alloys with approximately 10% TaC to approximately 1400 kg/mm for alloys with 90% TaC. The hardness-composition curves at 450 to 1200°C follow the same pattern as that of microhardness-composition at room temperature. The temperature coefficient of hardness at 700 to 1200°C has the highest value in alloys with approximately 20% TaC and the lowest in alloys with 80 to 90% TaC. Alloys with 80 to 90% TaC also have the highest melting temperature and can be recommended for testing as structural materials for parts working at high temperatures in nonoxidizing media. (OTS)

39618 CONTEMPORARY IDEAS ON THE THERMAL STABILITY OF REFRACTORY CERAMIC MATERIALS AND METHODS OF INCREASING IT: [A REVIEW]. G. V. Kukolev and I. I. Nemets. Zh. Vses. Khim. Obshchestva im D. I. Mendeleeva, 8: 155-61(1963). (In Russian)

39619 STROENIE I SVOISTVA SPLAVOV URANA, TORIYA I TSIRKONIYA. (Structure and Properties of Uranium, Thorium, and Zirconium Alloys). O. S. Ivanov. Moscow, Gosatomizdat, 1963. 380p.

Forty articles are included on the mechanical and corrosion properties of U, Th, and Zr and their alloys. Constitution diagrams, phase studies, thermal properties, and alloying effects of various materials are analyzed. Separate abstracts were prepared for each article. (R.V.J.)

39620 DIFFUSION OF ALUMINUM, SILICON, IRON, AND NICKEL IN γ, β, AND α-URANIUM MODIFICATIONS. D. K. Khakimova, Yu. O. Virgil'ev, and O. S. Ivanov. p.5-8 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Diffusion of Al, Si, Fe, and Ni in industrial U was studied, and corrections were made in the U angle for binary alloys with 10 at. % alloying elements. The results were in good agreement with published data except for U-Al, in which the temperature of three-phase equilibrium is taken at ~770 instead of 750°C. (R.V.J.)

39621 URANIUM REGION IN U-Al-Si SYSTEM CONSTITUTION DIAGRAM. Z. V. Svislunova and O. S. Ivanov. p.9-15 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

The uranium region was determined in a ternary U system with 4.0 at. % Al and Si, and the solid solutions were analyzed. (R.V.J.)

39622 URANIUM REGION IN U-Fe-Al CONSTITUTION DIAGRAMS. D. K. Khakimova, O. S. Ivanov, and Yu. S. Virgil'ev. p.16-21 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Diffusion of Al and Fe in U was determined using microstructures of alloys annealed at various temperatures. Isothermal cross sections were constructed at 1050, 970, 850, 775, 760, 730, 690, and 650°C. (R.V.J.)

39623 ALLOYING EFFECTS ON URANIUM β PHASE DURING TEMPERING. A. T. Semenchenkov and O. S. Ivanov. p.22-36 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Effects of alloying with Al, Be, Fe, Mo, Nb, Ni, Si, Th, Ti, Zr, and fissium on β phase uranium at γ (900°) and β (720°) tempering were studied. Uranium alloyed with Al, Si, Fe, Ni, Nb, and fissium retains its β phase, down to room temperature during cold water tempering, while U alloyed with 0.5 to 15 at. % Be, 0.5 to 5 at. % Ti, 0.4 to 30 at. % Zr, and 0.1 to 3.0 at. % Th do not retain the β phase at room temperature, but have an α' solid solution structure. Increased alloying with Zr, Nb, Ti, and Mo inhibit the β stabilizing effects of Si, Fe, and fissium. (R.V.J.)

39624 EFFECTS OF ALLOYING ON THE PHASE TRANSFORMATION TEMPERATURE OF URANIUM γ AND β SOLID SOLUTIONS DURING ABRUPT QUENCHING. G. I. Terekhov, R. Kh. Tagirova, and O. S. Ivanov. p.37-46 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

A special device was used for recording cooling curves of uranium alloys with 0.5 to 1.5 at. % Si, Al, Fe, and fissium, 0.5 to 8 at. % Mo, 1 to 22.5 at. % Nb, and 1 to 22.5 at. % Zr from 700 and 800°C at a rate of 30 to 1200°/sec. The examined specimens were prepared from 99.68% U, 99.99% Al, 98.3% Si, electrolytic iron, fissium (51 at. % Mo, 34.4 at. % Ru, 5.69 at. % Rh, 3.38 at. % Pd and 1.37 at. % Zr), 99.9% molybdenum, 99.3% niobium, and 99.78% iodide zirconium. The alloys were melted in an arc furnace in chemically pure argon at 900 to 1000°C. It was shown that the $\gamma \rightarrow \beta$ transformations for alloyed specimens begin as a rule at 650 to 670°C at a cooling rate of 1000°/sec. (R.V.J.)

39625 EFFECTS OF REPEATED TEMPERING ON CRACKING OF URANIUM ALLOYS. A. T. Semenchenkov and O. S. Ivanov. p.47-60 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Repeated tempering of uranium alloys in cold and boiling water from γ (900°) and β (720°) regions resulted in β phase retention and subsequent cracking. Cracking took place during tempering and not during the $\beta \rightarrow \alpha'$ transition. γ phase tempering in oil at 200° resulted in slow cooling without β phase formation even in alloys with 0.5 at. % Cr, 1 at. % Si, and 0.5 at. % fissium. Alloying with 3 to 5 at. % Zr, 2 to 5 at. % Nb, and 3 to 5 at. % Ti prevented cracking in alloys with 1 at. % Si, 1 at. % Fe, and 1 to 1.5 at. % fissium. (R.V.J.)

39626 TRANSFORMATION KINETICS OF β PHASE FIXED BY ABRUPT QUENCHING OF URANIUM ALLOYS WITH ALUMINUM, SILICON, IRON, NICKEL, MOLYBDENUM, AND FISSIUM. A. T. Semenchenkov and O. S. Ivanov. p.61-9 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Beta phase solid solutions of uranium with Al, Fe, Si, Ni, Mo, and fissium, fixed by quenching at room temperature and at 100 and 150°C, transform into α' phase. Isothermal diagrams for $\beta \rightarrow \alpha'$ at 25 to 670°C showed that the U-Si system transforms at a faster rate at <150°C, while in the fissium system the β phase is much more stable. A minimum β stability was found at 25 to 600°C. (R.V.J.)

39627 EFFECTS OF URANIUM ALLOY TEMPERING TEMPERATURE ON THE PHASE STATE OF ALLOYING ADMIXTURES. A. T. Semenchenkov and O. S. Ivanov. p.70-6 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Alloying elements diffused into γ uranium at 900°C are

retained in β and α'' phases during quenching and tempering at 100°C. At higher temperatures (300 to 500°) the alloying admixtures (Al, Si, Fe, Ni, Zr, Nb, and Mo) separate from the solution causing considerable hardening and decreased electric resistance of the alloys. (R.V.J.)

39628 THE PHASE STATES AND AGING OF LOW ALLOY (3 TO 5 AT. %) BINARY URANIUM ALLOYS WITH ZIRCONIUM AND MOLYBDENUM. O. S. Ivanov, G. N. Bagrov, and A. T. Semenchenkov. p.77-86 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

X-ray diffraction, dispersion hardening, and microscopic analyses of low-alloyed uranium with zirconium and molybdenum showed a low diffusion of alloying materials in α uranium (less than 0.2 at. % Zr and >0.1 at. % Mo). Maximum diffusion was observed in β uranium with 2.5 at. % Zr and 1.4 at. % Mo. Increased aging temperature to 450, 500, and 600°C reduced the hardness of alloys with zirconium and to a lesser degree with molybdenum. (R.V.J.)

39629 CONSTITUTION DIAGRAMS OF URANIUM–CHROMIUM ALLOYS. T. A. Badaeva and R. I. Kuznetsova. p.87-91 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

A constitution diagram was constructed of U–Cr with a eutectic point at 17.5 at. % Cr at 895°C. Admixtures of chromium do not effect the temperature of uranium $\gamma \rightleftharpoons \beta$ and $\beta \rightleftharpoons \alpha$ transformations. (R.V.J.)

39630 STRUCTURE OF URANIUM-RICH U–Ti–Nb ALLOYS AT 1000, 650, AND 600°C. L. I. Gomozov, L. A. Rubtsova, and O. S. Ivanov. p.92-105 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Studies were made of 74 specimens of U–Nb–Ti alloys containing up to 50 at. % alloying elements. Element distribution along radial cross sections was equal to 3:1, 1:1, and 1:3 at. % Ti and Nb. Constitution diagrams were constructed for 1000, 650, and 600°C. (R.V.J.)

39631 POLYTHERMAL DIAGRAM OF RADIAL SECTION AT Nb AT. %: Mo AT. % = 1:7 AND 80 AT. % URANIUM IN U–Nb–Mo ALLOY. G. I. Terekhov and R. Kh. Tagirova. p.106-8 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

X-ray diffraction and microstructure analyses were made and composition-hardness curves were constructed for U–Nb–Mo alloys at 900, 690, 660, 635, and 607°C after 120, 300, 360, 500, and 600-hour annealings, respectively. A polythermal diagram for the alloy with 80 at. % U and 1:7 at. % ratio of Nb:Mo was constructed and analyzed. (R.V.J.)

39632 DISINTEGRATION OF γ-SOLID SOLUTION IN U–Nb AND U–Zr–Nb ALLOYS. Yu. S. Virgil'ev and O. S. Ivanov. p.109-15 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

A tetragonal lattice was formed during tempering of Nb-rich binary U–Nb alloys. The short duration of the process during fast cooling and the low hardness of the lattice do not confirm a concept of the process as one of ordering. Decomposition of γ solid solution U with 15 to 27.8 at. % Nb, caused by isothermal tempering at 500°C, confirmed that an increase of Nb disturbs the homogeneous decomposition ($\gamma \rightarrow \gamma_2 + \alpha$), producing a heterogeneous ($\gamma \rightarrow \gamma_1 + \alpha$) and then ($\gamma_1 \rightarrow \gamma_2 + \alpha$) process. An increase of the total alloying content, replacement of zirconium by niobium, and an increase of the tempering temperature in ternary U–Zr–Nb alloys result in heterogeneous decomposition of γ solutions. (R.V.J.)

39633 GAMMA-PHASE VARIATIONS IN U–Zr–Nb–Mo CONSTITUTION DIAGRAMS BELOW 800°C. Yu. S. Virgil'ev. p.116-19 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Isothermal diagrams for Zr, Nb, and Mo diffusion in 70, 60, 50, and 40 at. % U at 800, 700, 650, 550, and 500°C were constructed and analyzed. (R.V.J.)

39634 MECHANICAL PROPERTIES OF URANIUM ALLOYS WITH 1 TO 40 AT. % MOLYBDENUM. V. K. Grigorovich and O. S. Ivanov. p.120-30 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Microstructure, hardness, and mechanical properties of U–Mo alloys with 1 to 40 at. % Mo were studied in specimens tempered at 800°C and annealed at 500°C for 24, 100, and 800 hours. The yield strengths of the alloys increased with Mo content to 12 at. % and decreased with higher contents. An increase of Mo content to 12 at. % reduced creep at 400°C and 5 kg/mm^2 pressure. A further increase to 40 at. % Mo showed no special effects. At 500°C and identical pressure the rate of creep continues to decrease with Mo contents to 20 to 40 at. %. (R.V.J.)

39635 YIELD STRENGTH AND CREEP-RUPTURE OF BINARY ALLOYS OF URANIUM WITH 20 TO 95 AT. % ZIRCONIUM AND 5 TO 50 AT. % NIOBIUM. V. K. Grigorovich and O. S. Ivanov. p.131-7 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Mechanical properties and creep-rupture of U–Zr and U–Nb at high temperatures and with various compositions were studied. (R.V.J.)

39636 TEMPERATURE EFFECTS ON MECHANICAL PROPERTIES AND CREEP-STABILITY OF BINARY ALLOYS OF URANIUM WITH ZIRCONIUM, NIOBIUM, AND MOLYBDENUM. V. K. Grigorovich and N. E. Sladkova. p.138-47 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Mechanical properties of U alloys prepared from 99.83% pure uranium, 99.4% pure iodide zirconium, 99.2% pure niobium, and 99.9% pure molybdenum were studied. Hardness and ductility tests were made of various specimens at 20 to 800°C. Tests of creep at 400°C and 5, 10, and 20 kg/mm^2 pressure showed a maximum creep resistance in uranium alloyed with 25 at. % Nb. (R.V.J.)

39637 MECHANICAL PROPERTIES OF DEFORMED BINARY ALLOYS OF URANIUM WITH ZIRCONIUM, NIOBIUM, AND MOLYBDENUM. V. K. Grigorovich and A. I. Dedyurin. p.148-61 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Mechanical properties were correlated with constitution diagrams and structure of binary forged uranium alloys with 1 to 15 at. % Zr, Nb, and Mo and for uranium alloys with 60 to 99 at. % Zr. (R.V.J.)

39638 EFFECTS OF THERMAL CYCLING ON CREEP AND STABILITY OF α PHASE BINARY ALLOYS OF URANIUM WITH TITANIUM, VANADIUM, AND CHROMIUM. N. E. Sladkova and V. K. Grigorovich. p.162-8 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Effects of cyclic heating on the dimensional and structural stability of α phase binary uranium alloys with Cr, Ti, and V were studied. The results of chemical analyses of U–Ti and U–V alloys were tabulated, and diagrams were constructed of the creep rate, deformation, and expansion of alloys exposed to 500 to 2000 thermal cycles (600 ⇌ 35°C). (R.V.J.)

39639 EFFECTS OF THERMAL CYCLING ON THE BEHAVIOR OF URANIUM–ZIRCONIUM–NIOBIUM ALLOYS. L. A. Gomozov and O. S. Ivanov. p.169-74 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Studies of γ phase U–Zr–Nb stability to thermal cycling between 35 $\rightleftharpoons$ 800°C (500 cycles) indicated that $\alpha \rightleftharpoons \beta \rightleftharpoons \gamma$ transitions were achieved for low-alloyed and $\alpha \rightleftharpoons \gamma$ transitions for high-alloyed systems. Specimens with 15 at. % Nb and 55 to 57 at. % Zr exhibited a rough surface that was smoothed out by increasing the amount of Nb. Cyclic treatment did not alter the surface or dimensions of binary alloys containing more than 20 at. % Nb or 97 at. % Zr. Introduction of Zr into binary U–Nb alloys with Zr at. % : Nb at. % ratios of 2 : 3 to 1 : 1 did not reduce the alloy stability to thermal cycling. However, the effective thermal neutron capture cross section is reduced. (R.V.J.)

39640 CORROSION RESISTANCE OF SOME URANIUM ALLOYS. L. I. Gomozov and O. S. Ivanov. p.175-84 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Tests were made with homogenized, welded, cylindrical, 5 × 22 mm alloy bars prepared from 99.84% pure U, 99.8% pure iodide zirconium, and 99.2% pure sintered Nb with 0.3% Ta and 0.25% Ti. Corrosion stability of alloys annealed from the γ phase in 300 to 400°C water is enhanced with increased γ-phase stability. The highest corrosion resistance was found with a Zr at. % : Nb at. % ratio of 2 : 3. High-alloyed uranium with niobium or molybdenum is easily inhibited in 250 to 300°C water. An optimum content of 20 to 27 at. % of Nb or Mo is suggested. A group of corrosion resistant low uranium alloys is given in increasing order of resistance: 5 at. % U–95 at. % Zr, 2 at. % U–0.5 at. % Nb–97.5 at. % Zr, 2 at. % U–0.5 at. % Nb–0.5 at. % Sn–97 at. % Zr, 8 at. % U–46 at. % Nb–46 at. % Zr, 5 at. % U–15 at. % Nb–2 at. % Sn–2 at. % Cs–76 at. % Zr. Alloys with a high scale resistance at 650 to 750°C tend toward a binary composition of 25 at. % Nb–75 at. % Zr, forming a solid solution base. Scale resistance of U–Mo alloys is higher with 17 at. % Mo and in ternary alloys with 17 to 23 at. % Mo and 2 to 3 at. % Zr. (R.V.J.)

39641 HARDNESS AND CORROSION PROPERTIES OF URANIUM–MOLYBDENUM–CHROMIUM ALLOYS. T. A. Badaeva and R. I. Kuznetsova. p.185-93 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Hardness and heat resistance of U–Mo–Cr alloys tempered from γ solution at 800°C and further annealed at 400 to 550°C were studied. The hardness of alloys with 3 to 14.8 at. % Mo and 4 to 3.2 at. % Cr and 19 to 31.8 at. % Mo and 4 to 1 at. % Cr after annealing at 550°C for 100 hours was 340 to 430 kg/mm^2. The alloys have a low resistance to air oxidation and water corrosion at high temperatures. Alloys with 19 to 31.8 at. % Mo and 4 to 1 at. % Cr have a relatively higher resistance to air oxidation and begin to deteriorate at 450 to 500°C, while alloys with 27.7 to 29.5 at. % Mo and 1.9 at. % Cr have a higher resistance to water corrosion and begin to deteriorate at 350°C after 200 hours. (R.V.J.)

39642 MECHANICAL PROPERTIES OF URANIUM–ZIRCONIUM–NIOBIUM ALLOYS. L. I. Gomozov. p.194-201 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Heterogeneous $\alpha + \gamma$ phase U–Zr–Nb alloys possess a higher yield strength than binary uranium alloys. The hardness of low-alloyed (up to 5 at. %) U–Zr–Nb system is 180 kg/mm^2 at 20°C, 150 kg/mm^2 at 150°C, and 45 kg/mm at 500°C with ductility (δ) not less than 2.5. The hardness of alloys with 12 to 18 at. % Zr and 4 to 7 at. % Nb, after 24 hour of 500°C annealing, was 85 kg/mm^2 and δ = 6%. For alloys with 10 to 14 at. % Zr and 16 to 20% at. % Nb, after 1000 hr annealing, the σ_w = 100 kg/mm^2 and δ = 5%. With 30 to 40 at. % alloying, Zr at. % ratio to Nb at. % = 1 : 4 to 1 : 5, the best heat resistance was obtained and ductility was satisfactory at 750°C. (R.V.J.)

39643 MECHANICAL PROPERTIES OF URANIUM–MOLYBDENUM–ZIRCONIUM AND URANIUM–ZIRCONIUM–NIOBIUM–MOLYBDENUM AT ELEVATED TEMPERATURES. G. N. Bagrov, Yu. S. Virgil'ev, and O. S. Ivanov. p.206-16 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Short-period creep-rupture tests of γ phase U–Zr–Nb–Mo alloys at 750°C showed that yield strength increased with increased alloying elements. With a constant U content the yield strength improves with increasing replacement of Zr by Nb and Mo. Creep resistance of γ-phase alloys tested for 100 hr at 750°C and 0.25 kg/mm pressure was improved by raising the total content of alloying elements to 40 at. %; it was also improved by Nb and Mo replacement of Zr. Short-period creep-rupture tests at 500°C on alloys tempered at 1000° and annealed at 500° for 100 and 1000 hr showed the best results with 70 at. % U. Alloy ductility dropped sharply with increased alloying elements and was close to zero with 60 at. % U. An increased amount of alloying at a constant ratio improves the creep resistance of the alloys, especially at 550 and 600°C. (R.V.J.)

39644 AGING MULTICOMPONENT SOLID SOLUTIONS ON URANIUM BASE. Yu. S. Virgil'ev. p.217-22 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Aging tests of U base (70 at. % U) Zr–Nb–Mo solid solutions additionally alloyed with Cr or V during isothermal annealing at 500°C showed that additions of Cr or V increase aging effects, inhibit γ stability, and cause faster disintegration at lower annealing temperatures. (R.V.J.)

39645 STRUCTURE OF Th–ZrC SYSTEMS. T. A. Badaeva and R. I. Kuznetsova. p.223-6 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Microstructure, hardness, and x ray diffraction analyses of Th–ZrC solid solutions showed a quasi binary cross section in a Th–Zr–C eutectic diagram (with 89 at. % Th). The diffusion of ZrC in Th is less than 0.5 at. % (Zr–C). (R.V.J.)

39646 HARDENING OF THORIUM BY CARBON. T. A. Badaev and R. I. Kuznetsova. p.227-36 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Carbon solubilities in Th at 1100, 1000, and 800°C were 10.8, 7.4, and 4.4 at. %, respectively, and 4.4 at. % at room temperature. Studies of mechanical properties indicate that at 300°C an admixture of 0.86 at. % C improves the yield strength of Th from 24.2 to 53.1 kg/mm^2. At 500°C the yield strength reaches 29.3 kg/mm^2 in systems with 3.64 at. % C in comparison to 11.8 kg/mm^2 in non-alloyed thorium. (R.V.J.)

39647 EFFECTS OF COOLING RATE ON ω-PHASE IN THORIUM–ZIRCONIUM–URANIUM ALLOYS. T. A. Badaeva and G. K. Alekseenko. p.237-45 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Cooling rate effects on ω-phase Th–Zr–U alloys were studied using x-ray, hardness, and microhardness methods. It was found that quenching of specimens with 90, 85, and

80 at. % Zr from 1000°C in ice water formed binary ω-phase Zr–U alloy with 85 to 91 at. % Zr and ternary alloys with 90 at. % Zr and up to 3.5 at. % Th and with 85 at. % Zr and up to 10 at. % Th. The ω phase improves the hardness of the examined alloys. A volume-centered β phase cubic lattice was fixed in the alloys with 80 at. % Zr and up to 16 at. % Th. (R.V.J.)

39648 MECHANICAL AND CORROSION PROPERTIES OF THORIUM–ZIRCONIUM AND THORIUM–ZIRCONIUM–URANIUM ALLOYS. T. A. Badaeva and G. K. Alekseenko. p.246-56 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Mechanical properties of Th–Zr–U tempered from $\beta_{Th}\beta_{Zr}\gamma_U$ solid solutions and subjected to extended annealing at 500°C were studied. The maximum stability (63 to 67 kg/mm^2 and 2 to 3% relative elongation) was observed in ternary saturated solid solutions containing 40 to 50 at. % U and 6 to 4 at. % Th. The alloys exhibited a very low resistance to air oxidation at 400 and 500°C and water corrosion at 350°C. A relatively stronger corrosion resistance was observed with alloys containing 85 and over at. % Zr. (R.V.J.)

39649 STRUCTURE AND CORROSION PROPERTIES OF THORIUM–ZIRCONIUM–TITANIUM ALLOYS. T. A. Badaeva and R. I. Kuznetsova. p.257-74 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Microstructure, hardness, and x-ray diffraction analyses were made of Th–Zr–Ti alloys (Th : Ti = 1 : 1 and 20, 30, and 50 at. % Zr) at 900 and 1000°C. The studies revealed a wide region of $\beta_{Th}\beta_{Zr}\beta_{Ti}$ solid solutions based on a volume centered cubic lattice expanding from the zirconium region. Tempering the ternary solid solution produced a $\beta \rightarrow \alpha'$ transformation that stabilizes with 400 to 500° annealing. Following a 3-hour annealing at 400°C the hardness of alloys with 63.5 to 74 at. % Ti and 1 to 1.5 at. % Th is 370 to 380 kg/mm^2; annealing at 500° for 500 hr softened the alloys. The highest corrosion resistance was found in alloys with 74 to 94.5 at. % Ti and 0.5 to 1 at. % Th. Titanium-rich alloys (84.5 to 94.5 at. % Ti) with 0.5 at. % Th exhibited high air oxidation resistance at elevated temperatures. (R.V.J.)

39650 STRUCTURE OF THORIUM–ZIRCONIUM–NIOBIUM ALLOYS. T. A. Badaeva and G. K. Alekseenko. p.275-93 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Constitution diagrams and structure of Th–Zr–Nb alloys were studied at temperatures from 550 to 1100°C. (R.V.J.)

39651 CORROSION PROPERTIES OF THORIUM–ZIRCONIUM–NIOBIUM ALLOYS. T. A. Badaeva and G. K. Alekseenko. p.294-8 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Investigations of corrosion properties of Th–Zr–Nb alloys, tempered from $\beta_{Th}\beta_{Zr}\beta_{Nb}$ solid solutions, in water at 300, 350, 400, and 500°C for 1000 hours revealed a relatively high corrosion resistance of Zr-base alloys with 1 to 15 at. % Th. A relatively high air oxidation resistance was also observed in alloys with 95 at. % Zr and 1 to 5 at. % Th and in zirconium alloys with 45.55 and 65 at. % Nb with 0.5 to 1 at. % Th. (R.V.J.)

39652 STRUCTURE OF $ThSi_2$–USi_2 ALLOYS. T. A. Badaeva and L. I. Rybakova. p.299-302 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

X-ray diffraction and microstructure studies of annealed $ThSi_2$–USi_2 showed that they form a continuous series of solid solutions corresponding to their isotypical lattices and parameters. (R.V.J.)

39653 STRUCTURE OF BINARY ALLOYS OF ZIRCONIUM WITH BISMUTH AND LEAD IN SOLID STATES. T. A. Badaeva and L. I. Rybakova. p.303-8 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Constitution diagrams and structures of binary Zr–Bi and Zr–Pb alloys were studied at 600 to 1100°C. It is shown that Bi exceeds the temperature of $\alpha \rightleftharpoons \beta$ zirconium transformation and results in a $\beta + \gamma \rightleftharpoons \alpha$ peritectoid reaction at about 900°C. The β-solid solution extends from 7.7 at. % Bi at 1100°C to 2.9 at. % Bi at 900°; α-solid solution diffusion is limited to 4.0 at. % Bi at 900°C and 2.8 at. % Bi at 600°C. Structures of zirconium alloys with 0.4 to 16.85 at. % Pb studied at 600 to 1100°C indicate a $\beta + \gamma \rightleftharpoons \alpha$ peritectoid reaction at 900°C; β-solid solutions are found with 3.8 at. % Pb. The maximum diffusion of lead in β zirconium at 1100°C is 7.5 at. %. The α region decreases to 3.8 at. % Pb at 600°C. (R.V.J.)

39654 CONSTITUTION DIAGRAM OF ZIRCONIUM REGION IN ZIRCONIUM–CHROMIUM–TIN ALLOYS. G. I. Terekhov and O. S. Ivanov. p.309-21 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Isothermal cross sections of the zirconium region were found in Zr–Cr–Sn constitution diagrams constructed for alloys with 10 at. % Cr + Sn at 500, 700, 850, 860, 900, 960, and 1000°C. At 970°C the system exhibits a four phase equilibrium, $\beta + Zr_4Sn \rightleftharpoons \alpha + ZrCr_2$. The region of β solutions is quite obvious, while the α phase appears as a narrow line next to the Zr–Sn system. (R.V.J.)

39655 CORROSION STABILITY AND MECHANICAL PROPERTIES OF LOW-ALLOY ZIRCONIUM ALLOYS WITH CHROMIUM AND TIN. G. I. Terekhov, R. Kh. Tagirova, and O. S. Ivanov. p.322-7 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Corrosion tests of Zr–Cr–Sn alloys in water and in air at 500°C showed that alloys with 1.5 to 2.5 at. % Cr and 0.3 to 0.5 at. % Sn have the highest corrosion resistance. The examined alloys also have better thermal resistance than pure zirconium. (R.V.J.)

39656 CORROSION STABILITY OF LOW-ALLOY Zr–Mo–Sn, Zr–Cr–Fe, AND Zr–Cr–Ni ALLOYS. A. T. Semenchenkov, O. S. Ivanov, and V. V. Bobrovskii. p.328-34 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Studies of Zr–Mo–Sn corrosion by water at 400°C under 300 atm pressure during 4750 hours indicated a very low resistance except for alloys with 0.5 at. % Mo and 0.25 to 0.5 at. % Sn, which exhibited a much higher stability. Zirconium alloys with Ni and Fe exhibited poor corrosion resistance at 400°C, 300 atm pressure, and 4100 hour exposure. Zirconium alloys with Cr and Fe tested at 400°C (4100 hr) and 500° (6000 hr) showed high corrosion resistance with an optimum for 1 at. % Fe and 0.75 to 1.25 at. % Cr. (R.V.J.)

39657 THERMAL RESISTANCE AND SCALE STABILITY OF ZIRCONIUM ALLOYS WITH ALUMINUM AND ADMIXTURES OF CHROMIUM, VANADIUM, AND MOLYBDENUM. V. B. Kishinevskii and V. K. Grigorovich. p.335-45 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Tests of mechanical properties of Zr–Al showed low ductility in alloys with 5 at. % Al at 800 to 1000°C. Additional alloying with V, Cr, and Mo improved hardness, and additions of up to 2 at. % Cr improve oxidation resistance. Scale resistance of zirconium alloys was inhibited by V, Al, and especially Mo. (R.V.J.)

39658 INVESTIGATION OF TERNARY ALLOYS OF ZIRCONIUM WITH ALUMINUM AND TIN. V. B. Kishinevskii and V. K. Grigorovich. p.346-53 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

An analysis was made of hardness, creep, mechanical properties, microstructure, and scaling of zirconium-base alloys with 3 at. % Al and 0, 1, 2, 3, and 5 at. % Sn and with 2 at. % Sn and 0, 1, 2, 5, 7.5, and 10 at. % Al. (R.V.J.)

39659 CORROSION RESISTANCE OF BINARY AND TERNARY ALLOYS WITH IODIDE, SPONGY, AND ELECTROLYTIC ZIRCONIUM BASE. L. I. Gomozov, V. B. Kushinevskii, O. S. Ivanov, and V. K. Grigorovich. p.354-77 of "Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya." Moscow, Gosatomizdat, 1963.

Corrosion resistance of Zr in water and steam was tested as a function of the composition and amount of alloying elements. Tests were made with Nb, Sn, Cr, Fe, and Mo, and comparisons were made of the effects of using iodide, sponge, and electrolytic zirconium. Effects of corrosion on the tensile properties of specimens were also examined. (R.V.J.)

39660 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUELS. Joseph Barta and Harry John Hedger (to United Kingdom Atomic Energy Authority). British Patent 933,984. Aug. 14, 1963. Filed May 25, 1961.

A dispersion of uranium monocarbide in Fe, Cr, or a Cr–Fe alloy is patented for use as a cermet reactor fuel. The melting point of the dispersion must be below 1600°C so that it may be prepared by casting to obtain a material of low porosity. Up to 30% by weight of the UC may be replaced by PuC. The atomic ratio of C to U should be between 1:1 and 0.8:1. The use of a Cr–Fe alloy as the metallic phase reduces the brittleness of a Cr–based composition and increases the oxidation resistance of a Fe-based composition. (M.P.G.)

Radiation Effects

Refer also to abstracts 39190 and 40394.

39661 (AAEC/TM-212) THE IRRADIATION BEHAVIOUR OF BERYLLIUM OXIDE BASED DISPERSION FUELS. A LITERATURE REVIEW. G. L. Hanna (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Aug. 1963. 25p.

The results of experiments on the irradiation behavior of BeO fueled with UO_2 and $(U,Th)O_2$ are summarized and discussed. The overall picture is still somewhat confused owing to the different experimental conditions used by different workers. A serious deficiency in most of the work is the failure to quote the energies of the irradiation neutrons, and it is not clear whether the observed changes are due to fission fragment or fast neutron bombardment. The irradiation behavior, in general, appears to be good up to fission doses of at least 5×10^{20} fissions cm^{-3} of dispersion. (auth)

39662 (BNL-6809) DETERMINATION OF THE SINGLE INTERSTITIAL MIGRATION ENERGY FROM STORED ENERGY AND THERMAL RESISTIVITY CHANGES IN IRRADIATED GRAPHITE. Donald G. Schweitzer (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 20p.

The model used to evaluate the single interstitial migration energy from property changes due to interstitials is extended to account for vacancy contributions. The annealing function obtained can be used to determine the relative contributions of the defects and is sufficiently sensitive to distinguish vacancy effects that are an order of magnitude less than interstitial effects. Application of the model to stored energy and thermal resistivity data yields the same values of the activation energy and temperature independent term obtained from c-axis and macroscopic length expansion rates. The results indicate that the stored energy associated with di-interstitial is at least ten times greater than the stored energy associated with the vacancy. The minor role of vacancies in phonon scattering is discussed. Analysis of the annealing function obtained from electrical resistivity changes in irradiated graphite indicates that the ratios of charge carriers to scattering centers varies with irradiation temperature below 55°C. Above this temperature the changes are attributed to equal contributions from vacancies and interstitials. (auth)

39663 (EURAEC-673) THE EFFECT OF RADIATION ON THE DUCTILE–BRITTLE TRANSITION IN PRESSURE VESSEL STEELS. Quarterly Report No. 9. E. Anderson, D. King, D. Langheinrich, M. Malone, and J. Spreadborough (Battelle Memorial Inst. International Div., Geneva). Apr. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 095-62-12-RDS. 59p.

After a short survey of general progress, the preparation and analysis of the iron and binary alloys of iron are described and briefly discussed. Recent tensile data on Armco iron are given. An etch pit procedure capable of revealing the dislocation structure in deformed polycrystalline iron samples by optical microscopy would be a useful complement to transmission electron microscope studies: the experiments done to this end are presented. It is shown that, of the etchant solutions proposed in the literature, Hahn's modification of Fry's reagent is the most suitable for the present purpose. The proposed capsule and basket arrangements for the irradiations in the High Flux Reactor at Petten are described. The approaches to the neutron dosimetry problem are outlined. (auth)

39664 (EURAEC-745) SWELLING OF URANIUM. Quarterly Report No. 11, April 1 and June 30, 1963. (Brussels. Centre d'Etude de l'Energie Nucleaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 087-62-4/RDB. 15p. (R-2231)

The neutron-irradiation damage in α-uranium is studied from a fundamental point of view, by means of the electron microscopy technique. Irradiation experiments were done at 80°C at a dose of 10^{17} and 2.5×10^{18} thermal neutrons · cm^{-2}. The damage is observed as rows of black dots, which could be identified as dislocation loops. The number of these rows per unit volume is proportional to the irradiation dose. The direction of the rows is in many cases one of the three principal axes: [001], [010], and [100]. The [112], [021], and [114] directions are also observed. The loops do not seem to be circular, but are more irregularly shaped. They were observed in as-irradiated α-uranium after a dose of 10^{17} thermal neutrons · cm^{-2}, some of them having a diameter of 500 Å, but most having a diameter between 100 and 200 Å. Some photographs of the dislocation structure of non-irradiated α-uranium are

also shown. Dislocation networks begin to form in slowly cooled α-uranium after annealing for 1 hour at 550°C (after deformation by rolling). (auth)

39665 (EURAEC-774) FISSION GAS RELEASE FROM URANIUM DIOXIDE. Quarterly Progress Report No. 10, April–June 1963. (FIAT. Sezione Energia Nucleare, Turin). Work Performed under United States–Euratom Joint Research and Development Program. Contract 021-60-9-RDI. 13p. (FN-E-36)

Thirteen experiments were performed during the quarter. Experimental data were obtained for four Mallinckrodt, five C.E.A. and four C.N.E.N. pellets. The release rate parameter D′ varied from 2.0×10^{-16} to 5.5×10^{-12} sec^{-1} at 1400°C. Further confirmation of the decrease of D′ with increasing irradiation doses was obtained. (D.L.C.)

39666 (HW-76263) GAMMA IRRADIATION EFFECTS ON CANDIDATE ELECTRONIC, LIGHTING, OPTICAL, INSTRUMENT, AND STRUCTURAL COMPONENTS FOR IN-REACTOR MONITORING EQUIPMENT. D. R. Doman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 23, 1963. Contract AT(45-1)-1350. 62p.

The effects of gamma radiation on the various instruments and optical, electronic, lighting, and structural components foreseen as applicable to in-reactor tube monitoring equipment were determined. In some cases literature searches indicated possible usable components. Where inconclusive results or no information were found components were subjected to gamma irradiation, usually from Co^{60} sources but in some cases from discharged reactor fuel elements or shut-down reactors. Except for one lighting test and one television camera vidicon test, components were irradiated while not operating, and pre- and post-irradiation characteristics were compared. From these tests and literature searches, acceptable materials for most tube monitoring equipment components for use up to 5×10^9 r were found. In some cases, radiation-induced effects had to be taken into consideration in the instrument design. Proper selection of materials has minimized radiation-induced equipment problems in the tube monitoring inspections of the irradiated PRTR pressure tubes since May 1961. (auth)

39667 (HW-77855) POST-IRRADIATION BURST TEST OF AN NPD TYPE ZIRCALOY-2 PRESSURE TUBE. L. J. Defferding and P. M. Jackson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 11, 1963. Contract AT(45-1)-1350. 17p.

The increase in yield and ultimate strengths of 18 and 15 per cent respectively is about the expected amount for the exposure of 2×10^{20} nvt (E > 5 Mev). The ultimate strength of the PRTR annealed section for similar exposures has increased up to 30 per cent. The fracture of the irradiated tube was ductile in appearance, full shear, but the pattern of elongation has shown a marked change. The maximum circumferential elongation was greatly reduced by irradiation from 20 per cent to 4 per cent while the maximum wall thinning changed from 26 to 21 per cent. Therefore most of the deformation occurred in a small area near the fracture. (auth)

39668 (N62-11316) RADIATION DAMAGE TO SILICON SOLAR CELLS. Quarterly Report, January 16, 1961–April 15, 1961. M. Abrahams, J. A. Baicker, and B. W. Faughnan (David Sarnoff Research Center, Princeton, N. J.). Apr. 30, 1961. Contract NAS5-457. 16p.

The phenomenological theory of the operation and damage of silicon solar cells was extended and applied with some degree of success to a number of electron and proton bombarded cells. Several of the parameters of the cells (diffusion length, lifetime, junction depth) as calculated on the basis of the theory using the measured spectral response and spectral damage characteristics agree with the values of these quantities measured independently. Sufficient data on electron damage is presented to allow a meaningful comparison of the photovoltaic data with the electron-voltaic data over the energy range from threshold to 800 kev; critical fluxes in the former case appear to be uniformly higher than in the latter case by a factor of roughly 300 which is independent of electron energy and cell polarity. Preliminary results with 19 Mev protons indicate a difference of about a factor of three in the critical flux for p on n cells compared with n on p cells, with that for the n on p cells being higher. The absolute values of Φ_C are not very much different from the values obtained with 8.3 Mev protons. No observable deterioration of the ultraviolet-irradiated cells was observed after the equivalent of 6 weeks of upper-atmosphere flux. Preliminary results of a metallographic study of proton-irradiated silicon are presented. (auth)

39669 (NARF-63-6T) EFFECTS OF REACTOR RADIATION ON CERAMIC-BONDED SOLID-FILM LUBRICANTS. F. A. Haley and R. H. McDaniel (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Aug. 30, 1963. Contract AF-33(657)-7201. 28p. (AD-417167; MR-N-302)

Two solid-film lubricant formulations ($PbS + MoS_2 + B_2O_3$ and MoS_2 + graphite + sodium silicate) were exposed to reactor radiation and tested for wear life on a Hohman A-6 wear tester. Substrate material was Inconel X, rub shoes were of Rex AAA, load per shoe was 110 lb, and sliding speed was 128 ft/min. Several test temperatures up to 1200°F were employed. It was concluded that a gamma dose of 1.47×10^{11} ergs/gm(C) and a neutron flux of 2.85×10^{16} n/cm^2 (E > 2.9 Mev) had no significant effect on the wear life of these films. (auth)

39670 (NP-13155) CHARGED PARTICLE RADIATION DAMAGE IN SEMICONDUCTORS. IX. PROTON RADIATION DAMAGE IN SILICON SOLAR CELLS. J. M. Denney and R. G. Downing (Space Technology Labs., Inc., Redondo Beach, Calif.). Aug. 31, 1963. Contract NAS5-1851. 40p. (MR-34)

A series of experiments using protons of energies from 6.7 to 26 Mev were performed to measure the energy dependence of proton radiation damage on p on n and n on p silicon and gallium arsenide solar cells. The experimental results indicate that: (a) the energy dependence experimentally observed in this energy range is in agreement with the inverse energy dependence predicted on the basis of Coulomb scattering and (b) the minority carrier diffusion length injection level dependence previously observed at 95.5 Mev is also observed at all the energies used in this series of experiments. The energy dependence is presented for solar cells under one sun equivalent radiation in terms of both K values and reciprocal critical fluxes. (auth)

39671 (NASA-SP-3003) HANDBOOK OF SPACE-RADIATION EFFECTS ON SOLAR-CELL POWER SYSTEMS. William C. Cooley and Robert J. Janda (Exotech, Inc., Alexandria, Va.). 1963. 114p.

A summary is given of some of the analytical methods and test data which can be used in designing radiation-resistant solar cell power systems. Prediction of solar cell degradation for earth satellites is hindered by inadequate knowledge of the fluxes and energy spectra of elec-

trons and protons in the magnetosphere. Radiation effects on solar cell cover slide materials, adhesives, transistors, and diodes are considered. (D.L.C.)

39672 (NP-13133) CHARGED PARTICLE RADIATION DAMAGE IN SEMICONDUCTORS. VIII. THE ELECTRON ENERGY DEPENDENCE OF RADIATION DAMAGE IN PHOTOVOLTAIC DEVICES. J. M. Denney and R. G. Downing (Space Technology Labs., Inc., Redondo Beach, Calif.). July 15, 1963. Contract NAS5-1851. 25p.

A series of experiments using electrons from 1 to 40 Mev was performed to measure the energy dependence of electron radiation damage in p on n and n on p silicon and gallium arsenide solar cells. The experimental results indicate that: (a) 1 ohm-cm p on n silicon and gallium arsenide solar cells respond according to predicted energy dependence relationships based on simple displacement theory and (b) 1 ohm-cm and 10 ohm-cm n on p silicon solar cells depart from the simple theoretical predictions by exhibiting a much greater sensitivity to incident electron energy. The details of the mechanism responsible for the departure of p-type silicon from simple displacement theory are not clear at this time. (auth)

39673 (NP-13137) CHARGED PARTICLE RADIATION DAMAGE IN SEMICONDUCTORS. VII. ENERGY LEVELS OF DEFECT CENTERS IN ELECTRON AND PROTON BOMBARDED SILICON. J. R. Carter and R. G. Downing (Space Technology Labs., Inc., Redondo Beach, Calif.). Feb. 15, 1963. Contract NAS5-1851. 25p.

Bound energy levels resulting from proton and electron bombardment of silicon were investigated through measurements of the temperature dependence of the Hall coefficient and Hall mobility. Three energy levels are found; these are located at 0.17 ± 0.01 ev and 0.40 ± 0.03 ev below the conduction band in n-type silicon and 0.29 ± 0.02 ev above the valence band in p-type silicon. These energy levels have been previously observed under varying conditions in electron and neutron irradiated silicon. Defect introduction rates were measured for each of these levels as a function of particle and particle energy. Protons are found to yield an introduction rate about 100 times greater than electrons in qualitative agreement with earlier lifetime studies. However, it is concluded that the recombination centers which control minority carrier lifetime may not be related to the bound energy levels which control the Hall coefficient and the majority carrier concentration. (auth)

39674 (REIC-ACCESS-67) MONTHLY ACCESSION LIST [ON RADIATION EFFECTS DATA]. Abstracts. (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). Sept. 15, 1963. Contract AF33 (657)-10085. 27p. (AD-417251)

A listing in abstracted form is presented on 71 articles on radiation effects which were accessioned and extracted for the REIC Technical Information File during the period Sept. 1 to 30, 1963. The list is arranged according to metallic materials, space environment and effects on materials, ceramic materials, polymeric materials, experimental devices and techniques, inorganic materials, organic materials, miscellaneous, and electronic materials and devices. (D.L.C.)

39675 (REIC-ACCESS-68) MONTHLY ACCESSION LIST [ON RADIATION EFFECTS DATA]. Abstracts. (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). Oct. 15, 1963. Contract AF33(616)-7375. 48p. (AD-417681)

References (139) on radiation effects on metallics, ceramics, polymers, inorganic materials, facilities, organic materials, and electronic materials, components, and devices are given to books and U. S. and foreign journals and reports published from May 1955 through August 1963. (P.C.H.)

39676 (SCR-672) THE EFFECT OF RADIATION ON THE MECHANICAL PROPERTIES OF POLYMERS. A BIBLIOGRAPHY OF THE UNCLASSIFIED LITERATURE, 1955–SEPTEMBER 1962. (New Mexico. Univ., Albuquerque). July 1963. For Sandia Corp., Albuquerque, N. Mex. Contract [AT(29-1)-789]. 58p.

A bibliography of ~440 references is presented which is arranged into sections dealing with polyacrylates, polyamides, polybutadienes and copolymers, polycarbonates, cellulosics, epoxy resins, polyesters, polyethers, polyethylenes, natural rubber, neoprene, phenolics, polypropylene, rubbers, silicones, polystyrenes, urethanes, polyvinylidenes, polyvinyls, and miscellaneous systems. Reviews, data compilations, books, and references dealing with dynamic mechanical properties are also listed. (D.L.C.)

39677 (TRG-Report-540) IRRADIATION OF BERYLLIUM AT ELEVATED TEMPERATURES. PART I. IRRADIATION OF RIG X-17 IN HIFAR. B. S. Hickman, G. Bannister, J. H. Chute, J. G. McCracken, R. Smith (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales); and J. C. Bell (United Kingdom Atomic Energy Authority. Reactor Group, Springfields, Lancs, England). July 31, 1963. 56p.

Results are given of an experiment in which beryllium metal, fabricated by six different routes, was irradiated to fast neutron doses of 3.5 to 5.5 × 10^{20} nvt at temperatures of 450, 550, and 650°C. The examination covered density and dimensional changes, hardness and tensile testing, and optical and electron microscopy. Comparisons are given of the behavior of irradiated specimens, as-received specimens, and control specimens given heat treatment similar to that received by the irradiated specimens. Volume changes in the irradiated specimens, due to the accumulation of helium gas into bubbles, are very small. It appears that the growth of gas bubbles in these materials occurred almost entirely at the grain boundaries and further, that the bubbles were larger in material that was heat treated before irradiation. Tensile properties were markedly affected by heat treatment, the elongation being much increased in most cases, but irradiation caused a marked decrease in elongation combined with increases in proof stress and ultimate tensile strength. The effect of irradiation was worst for irradiation and testing at 650°C and this is interpreted in terms of the distribution of gas bubbles at the grain boundaries. (auth)

39678 (WAPD-TM-313) THE EVOLUTION OF XENON-133 FROM SLIGHTLY IRRADIATED ZIRCONIA–URANIA PLATES. J. C. Clayton (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Aug. 1963. Contract AT(11-1)-Gen-14. 21p.

Zirconia-urania solid solution high density plates fabricated from ZrO_2 and slightly enriched UO_2 powders were irradiated with neutrons, and the amount of Xe^{133} released was measured as a function of temperature. Assuming a diffusion mechanism based on a model of a flat plate containing a uniform initial distribution of fission gas, diffusion coefficients were calculated for the 700 to 1250°C temperature range. The diffusion coefficient for Xe^{133} in slightly irradiated (1×10^{16} fissions/cc) single-phase tetragonal ZrO_2–26 wt % UO_2 plates can be represented by the equation, $D = 15 \exp(-92{,}275/RT)$; the activation energy is 92.3 ± 2.3 kcal/mole; and $\ln D_0 = 2.7 \pm 1.0$. (auth)

39679 (EURAEC-610) RESEARCH ON FUEL EVOLUTION — PLUTONIUM RECYCLING IRRADIATIONS IN EL-3. Special Report No. 6. (France. Commissariat a l'Energie Atomique, Paris). [1962]. Work Performed under United States–Euratom Joint Research and Development Program. 14p. (A translation)

Irradiations were carried out on standard fuel cartridges containing U^{235} and Mo, and on Al–Pu alloy cartridges ("napkin rings"). The cartridges and their location inside the reactor are described, and the operation of EL-3 during the irradiations are graphically plotted. (D.L.C.)

39680 SELF-IRRADIATION AND ANNEALING OF PLUTONIUM AND PLUTONIUM–ALUMINUM ALLOYS. R. O. Elliott (Los Alamos Scientific Lab., N. Mex.), C. E. Olsen, and G. H. Vineyard. Acta Met., 11: 1129-38(Oct. 1963). (LADC-5682)

The electrical resistivity of single-phase alpha and delta plutonium at 20°K increases with time. The initial rate of increase in resistivity of unalloyed alpha is greater than in alloyed delta by a factor of approximately 6. The increase in resistivity is attributed to radiation damage caused by the alpha activity in plutonium, and is believed to have its origin in lattice defects produced by the α-particles and their accompanying recoil nuclei. An appreciable fraction of the lattice defects is removed by annealing in the temperature range below 100°K. The self irradiation behavior of two-phase alloys consisting of alpha-plus-delta phase mixtures is also discussed. (auth)

39681 TEMPERATURE AND ILLUMINATION DEPENDENCE OF IRRADIATION DAMAGE IN SILICON. Herman J. Stein (Sandia Corp., Albuquerque, N. Mex.). Appl. Phys. Letters, 2: 235-6(June 15, 1963). (SCR-676)

Experiments showed that during the irradiation of silicon a reduction in temperature to 76°K reduced the damage rate, observed in room temperature lifetime measurements, by a factor of 20. Illuminating the sample during irradiation at low temperature increased the damage rate by a factor of 6. It was concluded that at least a major part of the temperature dependence of the defect introduction rate must be attributed to the charge state of the defects immediately after formation. (P.C.H.)

39682 DIRECT OBSERVATION OF RADIATION DAMAGE PRODUCED IN COPPER BELOW 30°K DURING ION BOMBARDMENT IN THE ELECTRON MICROSCOPE. L. M. Howe, R. W. Gilbert, and G. R. Piercy (Atomic Energy of Canada Ltd., Chalk River, Ont.). Appl. Phys. Letters, 3: 125-7(Oct. 15, 1963).

Ions emanating from coated emission filaments in the electron microscope were observed to produce spots and loop-like features in a Cu sample at a temperature below 30°K. The damage, visible due to a diffraction contrast effect, appeared identical to neutron damage at 50°C and depended on the emission efficiency of the filament. Uncoated filaments did not produce such damage. Formation of the spots is concluded to be independent of appreciable defect migration and to occur directly in the region damaged by the ion collision. Also, the spots apparently represent vacancy clusters formed in a depleted zone of the type postulated by Seegar. Formation of the loop-like features should also be independent of free interstitial migration. (D.C.W.)

39683 THE EFFECT OF NEUTRON IRRADIATION ON THE STRUCTURE AND MECHANICAL PROPERTIES OF ALLOY STEELS. Sh. Sh. Ibragimov, I. M. Voronin, and A. S. Kurglov. At. Energ. (USSR), 15: 30-7(July 1963). (In Russian)

Iron, a 1X16 MCB (16% Cr) with a ferrite structure containing carbides, the steels 2X2 MC, 2X6 MCT, 1X12 MC, and 1X16 MCB with a ferrite-perlite structure, and the austenitic steels 1X18 N9T (18% Cr and 9% Ni) and 1X18 N14MCB (18% Cr and 14% Ni) were subjected to neutron irradiation at temperatures of 200 to 500°C with an integral dose of 1.5×10^{20} to 7×10^{21} neutrons/cm^2. At a dose of 1×10^{20} neutrons/cm^2 for iron, and 3×10^{20} n/cm^2 for the 1X16 MCB steel, saturation takes place. The yield point increases from 29.5 to 51.5 kg/mm^2 for iron, and from 44.0 to 65.5 kg/mm^2 for the 1X16 MCB steel at a temperature of 200 to 240°C. The strength increases, and the relative elongation decreases due to strengthening by the formation of radiation defects which are completely annealed out at an irradiation temperature of 450 to 500°C. The addition of a small amount of an alloying element such as silicon or molybdenum to an austenitic stainless steel shifts the integral saturation dose toward higher irradiation doses. The radiation defects are annealed out at temperatures of 430 to 650°C. The changes in mechanical properties of the 2X2 MC, 2X6 MCT, and 1X12 MC steels during irradiation at 200 to 240°C are associated with the formation of radiation defects which strengthen the steel, but at 320 to 360°C the formation of radiation defects and also a change in the structural state of the steel are observed during irradiation. A redistribution and a change in the form and dimensions of the carbide phase are observed. (TTT)

39684 EFFECT OF FAST NEUTRON IRRADIATION ON THE THERMAL CONDUCTIVITY OF SILICON BETWEEN 80 AND 300°K. Halim J. Albany and Michel Vandevyver (Centre d'Etudes Nucleaires, Saclay, France). Compt. Rend., 257: 859-62(July 22, 1963). (In French)

The sharp decrease in the thermal conductivity of Si after neutron irradiation (1.2×10^{18} neutrons/cm^2) is analyzed using the Klemens model. It was found that the additional resistivity can not be explained alone by the increase of the diffusion in $\tau^{-1} = A\omega^4$. It is necessary to consider a larger contribution of the diffusion in $\tau^{-1} = c/L$, the decrease of L being attributed to the formation of fault accumulation. (tr-auth)

39685 SURFACE EFFECTS OF IONIZING RADIATION. D. S. Peck and E. R. Schmid (Bell Telephone Labs., Inc., Allentown, Penna.). Electronics, 36: No. 40, 34-6(Oct. 4, 1963).

Surface effects of high energy radiation on semiconductor devices is described. A model is presented as a practical way to evaluate semiconductor devices that are to be used in a radiation environment. (P.C.H.)

39686 FAST NEUTRON INDUCED CURRENT IN SEMICONDUCTOR DIODE GLASS DOSIMETER. G. A. Gilmour (Cornell Univ., Ithaca, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-10: No. 4, 18-22 (Sept. 1963).

A theory for the current induced in semiconductor diodes by fast neutron radiation is presented. Experimental verification of the theory is given for silicon rectifiers. It is shown that the signals induced by fast neutrons from a fission source are approximately 7% and 0.2% as large as the gamma-ray induced signals for silicon and germanium devices, respectively. (auth)

39687 RECENT DEVELOPMENTS OF NUCLEAR RESISTANT FLIGHT CONTROL AND COMPUTER SYSTEMS. Leonard B. Gardner. IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-10: No. 4, 47-55(Sept. 1963).

Engineering developments that have enhanced the ability

of flight control and computer system performance in a radiation environment are discussed. The radiation environments considered are those associated with natural and man-made space radiation and radiation from propulsion systems such as RIFT and NERVA. (auth)

39688 STRUCTURAL TRANSFORMATION IN NICKEL–CHROMIUM ALLOY (80 Ni/20 Cr) UNDER IRRADIATION. S. M. Astrahantzev and Yu. I. Konnov (Kurchatov Atomic Energy Inst., Moscow). J. Nucl. Mater., 10: 15-22(Sept. 1963). (In English)

The influence of reactor irradiation on the special structural state in nickel–20 wt % chromium alloy, known as the K-state, was investigated on the basis of electrical resistivity measurements. It is shown that two opposite processes may take place in the alloy under irradiation: destruction and formation of the K-state. Depending on the initial state one or the other process predominates. After irradiation of a cold-worked and quenched alloy its annealing promotes further transformation to the K-state, while the annealing after irradiation of a tempered alloy causes it to revert it to the same state. The attainable degree of transformation of the alloy to the K-state increased after irradiation (nvt = 5×10^{19} thermal neutrons/cm^2). (auth)

39689 THE EFFECTS OF NEUTRON IRRADIATION AT ELEVATED TEMPERATURES ON THE TENSILE PROPERTIES OF SOME AUSTENITIC STAINLESS STEELS. A. N. Hughes and J. R. Caley (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). J. Nucl. Mater., 10: 60-2(Sept. 1963). (In English)

The effects of neutron irradiation at 590 to 750°C on the tensile properties of three steels were studied. 20 Cr/25 Ni/Nb (0.01 wt % C, 0.7 wt % Nb), 20 Cr/25 Ni/Ti (0.01 wt % C, 0.3 wt % Ti), and 20 Cr/25 Ni/LC (low carbon, 0.005 wt % C, unstabilized). The specimens were in the form of 0.5 mm thick strip tensile specimens with a 25 mm × 6 mm gauge length and were tested over the temperature range 500 to 900°C. After irradiation at 590 and 750°C, only the 20 Cr/25 Ni/LC steel showed a small but consistent fall in UTS values. The major effect was a reduction in ductility of all three steels, which was accompanied by a change in fracture characteristics. (P.C.H.)

39690 OPERATION SAFETY OF SEALED RADIOACTIVE SOURCES. G. Vormum and H. J. Muenster (Inst. for Applied Isotope Research, German Academy of Sciences, Berlin-Buch). Kernenergie, 6: 419-28(Aug. 1963). (In German)

The operational safety of sealed sources depends on the manner of fixation of the activity and on the manner of closing. The presently used preparation methods are considered critically. By means of more load tests, the efficiency of individual source types was ascertained. On the basis of results, a formulated test scheme is discussed. (tr-auth)

39691 FURTHER EXPERIMENTS ON RADIATION DAMAGE DUE TO FAST-NEUTRON BOMBARDMENT IN PURE IRON OF VERY-HIGH PERMEABILITY. A. Ferro and G. Montalenti (Istituto Elettrotecnico Nazionale, Turin). Nuovo Cimento (10), 28: 1512-16(June 16, 1963). (In English)

Experimental results are given for the changes in magnetic properties of pure iron specimens. These specimens had a carbon content of 0.007 wt % or less and were prepared in such a way as to have a very high permeability (~150000). The specimens were irradiated in the swimming-pool reactor Avogadro with a fast neutron flux (≥1 Mev) of 1.1×10^{18}. (R.E.U.)

39692 NEUTRON DAMAGE IN MgO. G. W. Groves and A. Kelly (Cambridge Univ., Eng.). Phil. Mag. (8), 8: 1437-54(Sept. 1963).

Single crystals of MgO irradiated to a dose of 4×10^{19} nvt at < 200°C become very brittle, and the length of the slip bands spreading from a microhardness indent becomes very small. Damage is visible under the electron microscope, but is too small to identify positively. From the density of this damage, and the smallness in the increase of the lattice parameter, 0.09%, it is concluded that most of the ions which had been displaced subsequently returned to normal lattice sites during irradiation. Upon annealing, the damage coarsens and can be identified as prismatic dislocation loops of {110} Burgers vector lying on {110}. A crystal, irradiated to a dose of 5.4×10^{19} nvt at 650°C, contained similar dislocation loops, the majority, if not all, of which were of interstitial type. The damage in this crystal was homogeneous except for a narrow surface zone $\lesssim 1\ \mu$ deep, but when exactly similar crystals were annealed in air at 1200°C and 1350°C, the loops disappeared from a surface zone many microns deep whilst coarsening in the center of the crystal. The length of the slip bands spreading from an indent varied with depth accordingly. The implications of this result are discussed. (auth)

39693 RECOVERY OF DILUTED BINARY Al ALLOYS NEUTRON IRRADIATED AT 78°K. S. Ceresara (Istituto Sperimentale Metalli Leggeri, Novara, Italy), T. Federighi, and F. Pieragostini. Phys. Letters, 6: 152-5(Sept. 1, 1963). (In English)

Resistivity measurements were made on Al alloys with Cu, Mn, Si, Zn, Ag, Sn, and Mg that were annealed after neutron irradiation. The isochronal annealing curves show that each soluble element affected the lower temperature annealing stage in a characteristic way, while foreign atoms had little effect on most of the upper stage. Evidence was obtained that vacancy-type defects move in the upper stage while interstitials are released in the lower stage. (D.C.W.)

39694 SPIN-1 CENTERS IN NEUTRON-IRRADIATED SILICON. Wun Jung and G. S. Newell (Purdue Univ., Lafayette, Ind.). Phys. Rev., 132: 648-62(Oct. 15, 1963).

Electron paramagnetic resonance was used to study a number of fast-neutron-induced defects formed in pile-irradiated silicon and to follow their concentrations as a function of annealing. Measurements were made at 300, 77, and 4.2°K on samples that attained intrinsic resistivity during irradiation, using superheterodyne spectrometers operating at 24 and 9.4 kMc. Aside from the previously reported Si–N center, the most prominent lines of the spectrum arise from the $m_s = 0$ to ± 1 transitions of four spin-1 systems. The distinct symmetry and small production rate (≈0.05 center per fast neutron collision) indicate a class of well defined but relatively rare defects. Their g tensors, zero-field splitting tensors, and hfs are compatible with systems having two weakly interacting (111) dangling bonds separated by about 5 Å, giving the S = 1 hamiltonians in the triplet levels formed by the weak exchange interaction. Low-temperature measurements suggest that the singlet-triplet splitting lies between 3 and 50 cm^{-1}. Comparison with floating-zone silicon shows Center (II, III), which is dominant in unannealed samples, to be independent of impurity. The remaining three S = 1 centers, which grow and decay rapidly at higher temperatures, involve oxygen. Precise measurements of the parameters of the spin hamiltonians are given to permit reproducible identification of the centers. (auth)

39695 EFFECTS OF γ-IRRADIATION ON THE PERFORMANCE OF A RUBY LASER. W. Flowers and

J. Jenney (Univ. of Michigan, Ann Arbor). Proc. IEEE (Inst. Elec. Electron. Engrs.), 51: 858-9(May 1963).

A significant increase in the efficiency of ruby laser rods was obtained by irradiating the rods with Co^{60} gamma rays. The increase in efficiency seems to be due to a more efficient absorption of the pump light by color centers produced in the ruby by irradiation. The mechanism of energy transfer between the color centers and the laser transition has not yet been determined. (auth)

39696 THE EFFECT OF IONIZING RADIATION ON THE INTERNAL FRICTION OF SYNTHETIC QUARTZ. C. K. Jones (Imperial Coll. of Science and Tech., London) and C. S. Brown. Proc. Phys. Soc. (London), 82: 375-81 (Sept. 1, 1963).

The effect of ionizing radiation on the internal friction of 5 Mc shear waves in AT-cut synthetic quartz resonators was measured over a temperature range of 10 to 400°K as a function of the rate of growth of the parent quartz crystal. It is found that in all specimens the 50°K peak is removed by irradiation and that for slowly grown quartz the 20°K peak is enhanced by about 50%. A radiation-induced peak was found at about 325°K in fast-grown synthetic quartz. The results are discussed in terms of the current theories of the interaction of phonons and imperfections in dielectric crystals. (auth)

39697 OPTICAL PROPERTIES OF DIAMONDS IRRADIATED BY ELECTRONS AND NEUTRONS. [PART] I. C. D. Clark and J. J. Thompson (Univ. of Reading, Eng.). Rev. Gen. Electron., No. 197, 72-7(Apr. 1963). (In French)

Changes in the optical density, absorption spectra, coloration, and other optical properties of diamonds upon electron, gamma, and neutron irradiation are measured and compared. Annealing of these effects is also discussed. (T.F.H.)

39698 OPTICAL PROPERTIES OF DIAMONDS IRRADIATED BY ELECTRONS AND NEUTRONS. [PART] II. C. D. Clark and J. J. Thompson (Univ. of Reading, Eng.). Rev. Gen. Electron., No. 198, 57-60(Apr. 1963). (In French)

The effects of electron, photon, and neutron irradiations on the optical properties of diamonds are outlined. Thermal annealing of these effects is also discussed. (T.F.H.)

39699 INVESTIGATION OF SPIN-LATTICE RELAXATION IN NEUTRON-IRRADIATED QUARTZ. Ya. L. Shamfarov and T. A. Smirnova (Inst. of Radio-Physics and Electronics, Kharkov). Soviet Phys.-Solid State (English Transl.), 5: 761-3(Oct. 1963).

Measurements of the spin-lattice relaxation time T_1 in quartz single crystals at paramagnetic defects induced by bombardment with fast neutrons were carried out at a frequency of 9000 Mc by the pulse inversion method. The measurements were carried out in the temperature range from 1.7 to 4.2°K on two specimens that were subjected to different doses of radiation: $3 \cdot 10^{18}$ and $3 \cdot 10^{19}$ fast neutrons per cm^2. For the first specimen, in the range $1.7°K < T < 3°K$, $T_1 \sim T^{-1}$, and in the temperature range $3°K < T < 4.2°K$, $T_1 \sim T^{-4}$. For the second specimen, with a larger concentration of spin, $T_1 \sim T^{-1}$ only for $1.7°K < T < 2°K$, and for $2°K < T < 4.2°K$, $T_1 \sim T^{-4}$. Thus, a comparatively strong dependence of T_1 on concentration for T = 4.2°K becomes weak at T = 1.7°K. (auth)

39700 THEORY OF THE QUASI-ELASTIC SCATTERING OF COLD NEUTRONS IN LIQUIDS. V. S. Oskotskii (Semi-conductor Inst., Leningrad). Soviet Phys.-Solid State (English Transl.), 5: 789-91(Oct. 1963).

In addition to molecular jumps from one vibration center to another, continuous diffusion of the vibrational centers was taken into account in the quasi-crystalline model of liquids. Theoretical parameters were determined from a comparison with the experimentally determined angular dependence of the peak width of quasi-elastic scattering of neutrons in water at room temperature. Results: time between two jumps, $\tau_0 = 1.7 \cdot 10^{-12}$ sec; the average path traversed by a molecule by continuous diffusion between two jumps, $l_0 = 0.31$ Å; the average length of one jump, $l_1 = 1.63$ Å. (auth)

39701 DEPENDENCE OF SINGLE-CRYSTAL SPUTTERING ON THE DIRECTION OF INCIDENCE OF PARTICLES. D. D. Odintsov. Soviet Phys.-Solid State (English Transl.), 5: 813-15(Oct. 1963).

On the basis of simple assumptions, a semiempirical formula is given for the sputtering of single crystals. It agrees satisfactorily with experimental results. (auth)

39702 INELASTIC SCATTERING OF SLOW NEUTRONS IN SUBSTANCES WITH A SPIRAL MAGNETIC STRUCTURE. V. G. Bar'yakhtar and S. V. Maleev (Ioffe Inst. of Physics and Tech., Leningrad and Inst. of Physics and Tech., Kiev). Soviet Phys.-Solid State (English Transl.), 5: 858-61(Oct. 1963).

A study was made of inelastic neutron scattering by spiral magnetic structures associated with the absorption or emission of a single spin wave. Expressions were obtained for the scattering cross section and for the polarization of scattered neutrons. (auth)

39703 EFFECTS OF NEUTRON IRRADIATION ON THE THERMAL, ELECTRICAL AND MECHANICAL PROPERTIES OF GRAPHITE. J. Spreadborough and C. Tribuno. Termotechnica (Milan), 17: 397-410(June 1963). (In Italian)

The manufacture, moderating properties, and structure of graphite are reviewed. The damaging effects of irradiation on the electrical resistivity, thermal conductivity, specific heat, and Young's modulus, as well as variations of the lattice parameters and dimensional variations are discussed. Wigner energy stored in irradiated graphite and annealing at various temperatures to obtain a recovery effect are briefly dealt with. (TCO)

39704 EVALUATION OF INORGANIC MOTOR INSULATION UNDER SPACE ENVIRONMENT. O. P. Steele, III (Atomics International, Canoga Park, Calif.). 21p. (CONF-161-2)

From Dielectrics in Space Symposium, Pittsburgh, June 1963.

The development of electric power sources for the space program has imposed a whole new set of environmental conditions on dielectrics. Tests were conducted on an organic insulation under simulated high-temperature space conditions and under irradiation. The results appear very promising. (auth)

PHYSICS

General and Miscellaneous

39705 (AD-296233) BASIC RESEARCH IN THERMIONICS. PART I. CESIUM PERMEATION THROUGH TANTALUM. Summary Report No. 1, November 1, 1961 to October 31, 1962. R. A. Chapman, D. A. Peterman, P. F. Woerner, and G. F. Wakefield (Texas Instruments, Inc., Dallas). Jan. 1963. Contract Nonr-3705(00) fbm. 73p.

A plasma thermionic converter concept was proposed which uses cesium permeation through a tantalum emitter to obtain space-charge neutralization of electron current from this emitter. The concept was not feasible because the permeation rate of cesium through tantalum was too small. Cesium permeation through tantalum was studied at 400 to 1800 C with cesium pressures up to 13 mm Hg. This phenomenon was investigated for potential application as a hollow, ion-dispensing emitter for a plasma thermionic converter. Three methods were used in this study: measurement of ion current from a hollow, polycrystalline tantalum emitter internally connected to a cesium reservoir; measurement of weight-loss from a hollow, polycrystalline tantalum container with a cesium reservoir attached, with both suspended from a microbalance into a radiant furnace; and direct measurement of the diffusion coefficient in single-crystal and polycrystalline tantalum utilizing radioactive Cs^{134}. (auth)

39706 (AD-296764) MOMENTUM OF ELECTRONS IN SOLIDS. Annual Technical Report, September 1, 1961–August 31, 1962. (Athens. Univ.). Contract DA-91-591-EUC-1859. 6p.

The Compton line broadens into a band when monochromatic radiation scatters on bound electrons. The form of this Compton profile was investigated. The procedure was to obtain the form of the Rayleigh line resulting from the scattering and then to obtain the Compton profile by subtraction. The $Cu_{K\beta}$ and $Cr_{K\beta}$ radiations and the Li and Cr scatterers, however, proved insufficient for obtaining this resolution. (D.C.W.)

39707 (AD-414622) MAGNETOHYDRODYNAMIC SHOCK STRUCTURE IN A PARTIALLY IONIZED GAS. Research Report 153. E. T. Gerry, R. M. Patrick, and H. E. Petschek (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). June 1963. Contracts AF49(638)-1129 and Nonr-2524(00). 19p.

Strong magnetohydrodynamic shock waves in partially ionized hydrogen were studied. Dissipation due to slip between the ions and neutrals with the effects of viscosity and heat conductivity were included. Charge exchange processes control viscosity and ion slip. For Alfven Mach numbers below 2.5, the dominant mechanism is ion slip; for larger Mach numbers, the viscosity is important. The measured light intensity rise time and the electron temperature immediately behind the shock agree with theory. Behind the shock, measured electron temperatures are low. Electron temperatures were obtained by measuring the plasma soft x-radiation using thin carbon foils as filters. (auth)

39708 (ARL-62-459) ON THE THEORETICAL FOUNDATION OF THE ONE-ELECTRON APPROXIMATION. Lars T. Hedin (Uppsala Univ.). Sept. 1, 1962. Contract AF61(052)-351. 33p. (AD-296972; TN-84; CONF-208-1)

From International Symposium on Local Properties of Perfect Crystals, Geneva, July 1962.

The one-electron approximation is discussed qualitatively, and the work of Bohm-Pines, van Hove-Hugenholtz, and Luttinger are briefly reviewed. A method for handling quasi-particles is formulated. The Hartree-Fock equations are augmented with a polarization potential. The orbitals and orbital energies are reinterpreted to be related to exactly defined quantities of the many-body system. (auth)

39709 (ARL-63-125) RESEARCH ON EXPERIMENTAL EVALUATION OF SPUTTERING YIELD RATES. K. B. Cheney, E. E. Rogers, and E. T. Pitkin (Astro. Div. of Marquardt Corp., Van Nuys, Calif.). Apr. 12, 1963. Contract AF33(616)-8120. 90p. (AD-415285)

Phenomena associated with the impact of high energy ions upon solid surfaces under conditions relevant to ion rocket operation were investigated. The sputtering ratio was determined for Xe and Ar ions incident upon Cu, W, Mo, Si, and Ti with energies from 1.5 to 39 kev and at incidence angles from 2 to 90°. The effect of target temperatures on the sputtering ratio was also investigated. The number of secondary particles produced per incident ion, along with their energy and angular distribution, was determined as functions of ion energy and incidence angle. Analysis of theoretical concepts of sputtering and existing empirical data led to recommendations of likely materials for ion rocket use. 155 references. (auth)

39710 (ASD-TDR-63-865) INVESTIGATION OF CAPILLARY EMITTER THERMIONIC CONVERTERS. D. L. Dresser, J. D. Dunlop, H. Huber, R. LeBihan, V. L. Hill, N. D. McMurray, and K. E. Muszer (General Motors Corp. Allison Div., Indianapolis). Aug. 1963. Contract AF33(616)-8299. 190p.

A random current theoretical model is formulated to describe the emission of ions and electrons from a capillary thermionic emitter. Extensive experimental results from monocapillary and multicapillary devices are shown to be in good agreement with the theory. Practical power densities of 5 to 15 watts/cm^2 were obtained between 1900 and 2100°K. A modified capillary emitter in which no cesium flow is required was also investigated and found to agree wtth the random current model. Ion current measurements, high frequency oscillations, and spectroscopic data are used to interpret the operating conditions of the capillary emitter. Technology developments are reported on the subjects of emitter fabrication and chemical vapor deposition. (auth)

39711 (BNL-794) EVALUATION OF ATOMIC LEVEL WIDTHS. Nazakat Ullah (Brookhaven National Lab., Upton, N. Y.). Apr. 1963. Contract AT-30-2-GEN-16. 18p. (BNL-T-303)

Computer programs for the evaluation of auto-ionizing level widths are described. FORTRAN listings are given for the calculation of electron-ion potential, irregular Coulomb wave functions for negative (attractive) Coulomb parameter, numerical integration of the radial wave equation, and the values of the partial level widths as a function of channel radius. (auth)

39712 (BNL-6764) NUMERICAL SOLUTIONS FOR DIFFUSION IN A SPHERE, CYLINDER, AND PLATE. Allan Auskern (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract [AT(30-2)-Gen-16]. 7p

The diffusion equation solutions for the diffusion of gases from a sphere, cylinder, and plate were programmed for

~0.01 increments of the fractional completion value. The Dt/a^2 results are tabulated for a range of fractional completions from 0.04 to 0.99, which are reported to the nearest 0.0001. (D.L.C.)

39713 (BNL-7240) MEASURED VIBRATIONAL FREQUENCY DISTRIBUTIONS OF Ni, V, Ti, AND $Ti_{.67}-Zr_{.33}$. B. Mozer, K. Otnes, and H. Palevsky (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 18p. (CONF-204-3)

From International Conference on Lattice Dynamics, Copenhagen, Denmark, Aug. 1963.

The BNL cold neutron facility was used to obtain inelastic scattering cross section data from three first-row transition elements, titanium, vanadium, and nickel, and a random binary alloy $Ti_{.67}-Zr_{.33}$. From the data, vibrational frequency distributions were computed using an incoherent scattering approximation. These distributions exhibit peaks corresponding to major critical points. A comparison of the distributions from the different samples leads to the following conclusions: 1) The shape of the frequency distributions of the b.c.c. metal (V) and f.c.c. metal (Ni) are remarkably similar, the relative positions of the critical points being the same for both; 2) The frequency distribution of the h.c.p. metal (Ti), which has two atoms per primitive cell, shows structure corresponding to acoustical and "optical" modes of vibration; 3) The titanium–zirconium alloy has the h.c.p. structure, and its experimental frequency distribution is similar to that of titanium, except at low frequencies where alloying with the heavier mass zirconium atoms tends to smear out the peaks corresponding to acoustical modes. Measured frequency distributions were obtained for the titanium–zirconium alloy slightly above and below the critical temperature for the phase transition to b.c.c. structure. The frequency distributions in the two phases are different, the most striking feature being a shift of the high frequency critical points to lower values in the high temperature (b.c.c.) phase. (auth)

39714 (BNL-7325) MAGNETIC STRUCTURE STUDIES AT BROOKHAVEN NATIONAL LABORATORY. L. M. Corliss and J. M. Hastings (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 16p. (CONF-232-1)

From International Colloquy on Neutron Diffusion and Diffraction, Grenoble, France, Sept. 1963.

The results of some current or recently completed investigations of magnetic structure and magnetic transitions in Ni_5Er, $MnSn_2$, $MnSe_2$, and Cr_2O_3 are presented. (D.C.W.)

39715 (BSD-TDR-63-109) A GRAPHITE INERT GAS HEATER FOR MHD STUDIES. J. Klepeis (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). May 1963. Contract AF04(694)-33. 11p. (AMP-116; AD-416392)

A description is given of the design and construction of a graphite inert gas heater used for MHD studies at temperatures up to 2000°K. Heater performance and two methods for making the high temperature inert gas electrically conductive are described. (auth)

39716 (CONF-186-3) ELASTIC SCATTERING OF ATOMS AND MOLECULES IN THE THERMAL ENERGY RANGE. Final Report. Richard B. Bernstein (Michigan. Univ., Ann Arbor and Wisconsin. Univ., Madison). [1963]. Contract [AT(11-1)-321]. 33p.

From 3rd International Conference on the Physics of Electronic and Atomic Collisions, London, July 1963.

The goal of research on elastic scattering of atomic (or molecular) beams is the elucidation of the interaction potential V(r). The discussion was confined to thermal energy collisions (<1 ev), sensitive primarily to the attractive part of the potential. Studies of the velocity dependence of the differential and total elastic scattering cross sections yielded information as follows: the functional form of the long-range attraction, $V \sim -C/r^6$, from differential cross sections $I(\theta)$, at low angles, $I(\theta) \propto \theta^{-5/3}$; the attractive potential constant C, from total cross sections, $Q \propto (C/v)^{1/3}$; the depth of the potential well ϵ, from the rainbow effect in $I(\theta)$, $\theta_r = f(\frac{1}{2}\mu v^2/\epsilon)$; the equilibrium separation r_m, from de Broglie interference producing undulations in $I(\theta)$; the product ϵr_m, from extrema in Q(v), and thus r_m (from absolute Q's); and observation of m maxima in plots of $vQ^{1/3}$ vs. v^{-1} (termed elastic impact spectra) implies the existence of at least m bound states (discrete vibrational levels of zero angular momentum for the composite system). (auth)

39717 (GEST-2021) RESEARCH AND DEVELOPMENT PROGRAM OF THERMIONIC CONVERSION OF HEAT TO ELECTRICITY. Technical Summary Report. (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Aug. 30, 1963. Contract NObs-88578. 95p.

Two emitter-collector spacing configurations for thermionic converters successfully completed component testing. A thermionic diode configuration, making available a close match to the environment expected on spacing configurations in nuclear thermionic diodes, is in the final stages of assembly. An assembly to allow the testing of a number of concepts of possible cesium passages from one thermionic diode to the next in a series arrangement was designed and fabricated. An electron-beam furnace for the study of UO_2-refractory metals interactions at temperatures from 1650 to 2200°C completed the checkout phase. Careful characterization of two grades of tungsten was completed and samples of UO_2 clad in tungsten are under test. An experimental study to determine the phase equilibria between Y_2O_3 and four refractory metals (tungsten, rhenium, tantalum, and molybdenum) revealed no intermediate compounds along the pseudo-binaries Y_2O_3-W, Y_2O_3-Re, Y_2O_3-Ta, or Y_2O_3-Mo between 1500°C and 2000°C. No indication of metal solubility in Y_2O_3 was observed by x-ray techniques. A search for reaction between cesium vapor and Y_2O_3 at 1600°C revealed no reduction of Y_2O_3 at a cesium vapor pressure of 4 torr. The thermal expansion coefficient of Y_2O_3 was measured to be: $\alpha \times 10^6 = 5.143 + 0.185\ T^{1/2} - 0.0021\ T$, where: α is expressed in $°C^{-1}$ and T is expressed in °C and encompasses the range 75°C < T < 1050°C. The melting point of Y_2O_3 was measured to be 2420°C ± 35°C. The development of high temperature metal-to-ceramic seals is getting underway. (auth)

39718 (MND-2934) A STUDY PROGRAM ON CESIUM VAPOR-FILLED THERMIONIC CONVERTERS HAVING IRIDIUM EMITTERS. Yearly Summary Report, November 1, 1961–October 31, 1962. M. E. Talaat, D. S. Trimmer, and A. J. Kennedy (Martin-Marietta Corp. Aerospace Div., Baltimore). Dec. 1962. Contract Nonr-3639 (00). 87p. (AD-296020)

An extensive mapping of the performance of cesium vapor-filled energy conversion devices was obtained for the high-vacuum work function emitter materials, iridium and rhenium, for the interelectrode gap of 0.030 in. Characteristic current-versus-voltage curves and summaries of the output power density and efficiency are given for the emitter temperature range of 1550-2000°K and the cesium temperature range of 475-600°K. The data show a sys-

tematic superiority of iridium to rhenium. Tests with a platinum emitter device confirm the trend of good performance in cesium vapor with high vacuum work function emitter materials. Data are given showing a highly precise agreement between two iridium filament emitter devices and an electron bombardment heated device with iridium emitter. At the emitter temperature of 1700°K, liquid cesium temperature of 525°K, and interelectrode gap of 0.030-in., the output power density of the three devices was 5.6 ± 0.2 w/cm^2 and the energy conversion efficiency was 14.25 ± 1.25%. (auth)

39719 (MND-2945-3) NUCLEAR FUEL (OXIDE) CLAD THERMIONIC CONVERTERS. Quarterly Technical Progress Report, May 1 through July 31, 1963. (Martin-Marietta Corp. Aerospace Div., Baltimore). Aug. 15, 1963. Contract AF33(657)-10077. 61p. (AD-415102)

Fabrication of the components for the FDM-1 converter and its back-up device was completed. The FDM-1 converter was assembled, and preparations for testing were completed. Performance testing was initiated, and a total of 330 hours of operation above 1000°K in a cesium environment were logged. The peak emitter temperature reached was 2000°K with a thermionic output of nearly 2 watts/cm^2. Indications of a cesium leak were observed, and the device was shut down for examination. A 500-hour thermal endurance test of the clad fuel pellets was performed. A post-test examination was conducted, and no diffusion of UO_2 into the cladding was observed. A thermal conductivity test specimen was exposed to a temperature of 1550°C for 500 hours with the result that some intergranular diffusion was noted. The post-test examination of the vacuum emission test pellet was also completed. The design of the advanced double-diode thermionic converter utilizing the results of prior efforts was initiated. (auth)

39720 (NAA-SR-8377) TRANSLATION-PERMUTATION OPERATOR ALGEBRA FOR THE DESCRIPTION OF CRYSTAL STRUCTURES. I. IDEAL CLOSEST PACKING. W. G. Gehman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 30, 1963. Contract AT-11-1-GEN-8. 39p.

The foundations of an abstract algebra for the description of crystal structures are developed in terms of ideally closest packed structures, and are initially applied to such structures. All the spatial information of closest packed structures can be derived in terms of (a) the geometry of the atoms (A positions) and the plane, triangular interstices (B and C positions) of a closest packed p6mm monolayer, and (b) the permutations induced among these A, B, C positions by translations from one monolayer midplane to another. The mathematical device used to correlate this information is a translation-permutation vector operator. Since this operator is closely related to the basic concept of a layer-by-layer crystal growth process, the algebra is readily extensible to crystal structures that are defective, due to many kinds of nonperiodic accidents of growth. The application of the algebra is illustrated by simple descriptions of the ten standard ionic crystal structures and the spinel structure, and by a short discussion of the description of classical stacking faults and point defects. (auth)

39721 (NP-13148) THE FEASIBILITY OF LARGE SUPERCONDUCTING COILS. Research Report 160. Z. J. J. Stekly (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Sept. 1963. 29p.

Problems associated with superconducting materials, structural integrity, transition into the normal state, control of the magnetic field, and maintenance of the cryogenic environment are discussed. The limitations of field strength imposed by the material used are concluded to be, presently, the only fundamental limitations on coil size. (auth)

39722 (NRL-5967) STARK PROFILE MEASUREMENT OF THE LYMAN-α AND LYMAN-β LINES OF HYDROGEN. R. C. Elton (Naval Research Lab., Washington, D. C.). May 10, 1963. 32p. (AD-417850)

A T-type electromagnetic shock tube was used for the detailed study of Stark broadened lines in the vacuum ultraviolet. Measurements of the Lyman-α profile from an optically thin region (0.03 percent admixture of hydrogen in 40 mm-Hg helium) indicated agreement to within 10 percent with recent calculations that included the broadening effects due to electron impacts, as opposed to the Holtsmark theory which differs by a factor of ~3 on the wings when the theoretical curves are normalized at equal slope. A temperature of $(20.5 \pm 1.6)10^3$°K was determined from a line-to-continuum ratio measurement for helium. Density measurements from the visible continuum gave $N_e = (3.6 \pm 0.4)10^{17}$. The Rankine-Hugoniot equations predicted $N_e = (4.8 \pm 1.9)10^{17}$ and $T = (20.0 \pm 1.0)10^3$°K from the measured shock velocity. A calculated spectral emissivity of 0.09 ± 0.06 at 1217.7 Å compares with 0.10 ± 0.02 as found experimentally by adding known amount of hydrogen until saturation occurs. It is thus possible to produce near-blackbody radiation from homogeneous plasmas of controlled optical depths. Such plasmas can possibly be used as intensity standards at other wavelengths in the vacuum ultraviolet by using other gases having strong lines appropriately spaced. Similar measurements on the Lyman-β line support these results. 50 references. (auth)

39723 (R63SD76) A KINETIC MODEL FOR BINARY GAS MIXTURES. Bernard B. Hamel (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). July 25, 1963. 37p.

A method was developed for treating the Boltzmann equation for a binary gas mixture with inverse fifth power molecular interaction. This method involves replacing the complete collision integral in the Boltzmann equation with a kinetic model. This kinetic model reproduces the collisional transfer of momentum and energy for Maxwell molecules, as well as conserving mass, momentum, and energy. The derived model equation and its linearized forms represent a much simplified version of the collision integrals, which can provide a means of analyzing difficult initial and boundary value problems for a binary gas mixture. (auth)

39724 (SC-4796(RR)) SWAP—A COMPUTER PROGRAM FOR SHOCK WAVE ANALYSIS. L. M. Barker (Sandia Lab., Albuquerque, N. Mex.). Oct. 1963. Contract AT(29-1)-789. 61p.

The Shock Wave Analyzing Program (SWAP), written for the CDC 1604 computer to solve problems of one-dimensional shock wave propagation in solids, is described. The program uses the method of characteristics and elastic-plastic theory. Although presently limited in pressure range, it is capable of treating quite general one-dimensional configurations, including those in which spallation occurs. The program listing and sample problems are included. (auth)

39725 (UCRL-7264) THE CAUSE OF THE OBSERVED POLARIZATION OF ELECTRON-INDUCED RADIATION FROM HELIUM. Robert H. McFarland (California. Univ.,

Livermore. Lawrence Radiation Lab.). May 15, 1963. Contract W-7405-eng-48. 15p. (CONF-186-2)

From 3rd International Conference on the Physics of Electronic and Atomic Collisions, London, July 1963.

Improved measurements of threshold excitation and polarization of radiation from helium excited by electrons led to the conclusion that previously reported anomalies are of experimental origin. Helium lines, λ = 4922, 4388, and 5016 Å, exhibit polarization energy dependencies similar to that previously reported for λ = 3889 Å. Helium lines λ = 4922 and 4388 Å have excitation probability energy dependencies through limited energy ranges as predicted by theory. A tentative explanation of earlier results involves the contribution to both the excitation probability and the polarization of radiation caused by radially directed electrons elastically scattered from the electron beam. Attempts to reduce the radial travel of electrons have resulted in threshold and near-threshold polarization measurements which approach expected magnitudes. (auth)

39726 (UCRL-Trans-989(L)) ON PROPAGATION OF INSTANTANEOUS EXCITATIONS IN A MEDIUM WITH A NONLINEAR DEPENDENCE OF TENSIONS ON DEFORMATIONS. G. I. Barenblatt. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore), from Priklad. Mat. i Mekhan., 17: 455-60(1953). 14p.

The propagation of plane waves in a half-space, the material of which satisfies an arbitrary relation of the tensions with the deformations, is studied by a method used by Sedor for constructing accurate solutions of various problems of the mechanics of continuous media. (auth)

39727 INFLUENCE OF WALL CONDUCTANCE ON MHD ENERGY CONVERSION. William T. Snyder (New York State Univ., Stony Brook) and Lun King Liu. AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 2165-6(Sept. 1963).

The effect of finite electric conductivity walls normal to the magnetic field in a constant area MHD generator configuration is investigated. The flow is assumed to be laminar and steady with constant properties. The relation between external load resistance and internal resistance of fluid and channel walls that must be satisfied for maximum power output is derived. (C.E.S.)

39728 ON THE ROLE OF THE SOMMERFELD AND DARWIN CORRECTIONS IN THE CENTRAL FIELD PROBLEM. W. Hanus (Copernicus Univ., Torun, Poland). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 473-7(1963). (In English)

First order perturbation formulas for spin-orbit interaction, Sommerfeld and Darwin corrections to the central field problem that were previously used for hydrogen-like atoms, were applied to the case of many-electron atoms. Atoms with one electron outside a closed shell are considered in particular. (C.E.S.)

39729 FUNCTIONAL METHODS IN THE THIRRING MODEL. I. Bialynicki-Birula, J. Sniatycki, and S. Tatut (Univ. of Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 479-82(1963). (In English)

The prescription of Schwinger in evaluating gauge invariant induced current is used in the Thirring model. An exact solution is obtained. (auth)

39730 GAUGE COVARIANT AND GAUGE INVARIANT GREEN FUNCTIONS. CONNECTION BETWEEN ZUMINO'S AND MANDELSTAM'S FORMULATIONS. I. Bialynicki-Birula (Univ. of Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 483-5(1963). (In English)

It is shown that Zumino's and Mandelstam's formulations of quantum electrodynamics are completely equivalent. The gauge freedom of Green functions in Zumino's formulation corresponds to the arbitrariness in the definition of Green functions in Mandelstam's formulation. (auth)

39731 MEASUREMENT OF THE ABSORPTION COEFFICIENTS OF ARGON AND NEON FOR SOFT X RAYS. Francois Wuilleumier (Faculte des Sciences, Paris). Compt. Rend., 257: 855-8(July 22, 1963). (In French)

The absorption coefficients of Ne and Ar were determined between 2 and 8 Å by continuous registration of their absorption spectrum. The oscillation force of the K level of Ar was calculated. (tr-auth)

39732 "DUOPLASMATRON" ION SOURCE WITH 150 mamp PULSES PER MICROSECOND. Jean-Loup Belmont and Noel Felici (Universite et Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., 257: 895-7(July 22, 1963). (In French)

A duoplasmatron source to obtain ion pulses up to 150 mamp for 1 μsec was studied. With a recurrence of 2260 per second, the mean current reaches 400 μamp, and the hydrogen consumption is approximately 4 cm^3/hr at atmospheric pressure. (tr-auth)

39733 RECENT PROGRESS IN MAGNETOHYDRODYNAMICS. Clifford Mannal (General Electric Co., Philadelphia). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-10: No. 4, 8-17(Sept. 1963).

Advances in magnetohydrodynamic power generation are reviewed with particular reference to both land-based and aerospace designs. A brief comment is also made on aerodynamic advances. (auth)

39734 RAMAN SPECTRUM OF CESIUM IODIDE. N. Krishnamurthy and R. S. Krishnan (Indian Inst. of Science, Bangalore, India). Indian J. Pure Appl. Phys., 1: 239-41(July 1963).

The Raman spectrum of a single crystal of cesium iodide, which belongs to the CsCl structure, was recorded for the first time using 2537 Å excitation. The spectrum is quite intense and consists of a series of closely spaced Raman lines. Twelve Raman lines with frequency shifts 19, 22, 44, 61, 91, 94, 106, 110, 124, 137, 155, and 181 cm^{-1} were identified. The frequencies of the seven principal modes of oscillation of cesium iodide structure were worked out and the observed Raman lines were identified as the octaves and combinations of these seven modes. (auth)

39735 CONDITIONS FOR THE MAXIMUM SIGNAL FROM A NUCLEAR RESONANCE MEASUREMENT USING A FLOW-TYPE DETECTING ELEMENT. A. I. Zhernovoi. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 942-4(July 1963). (In Russian)

The conditions for a maximum amplitude for a signal obtained from a flow-type detecting element used in magnetic nuclear resonance studies are discussed. A liquid, polarized by an outside magnetic field, with magnetizable nuclei is assumed to flow through the detecting element around which a coil is wound capable of producing an oscillating magnetic field. The vector of the magnetizable nuclei will possess an angle of inclination with respect to the outside field. This angle depends on the distance traveled by the liquid through the detecting element. It is shown that the maximum amplitude of the detected signal is obtained when the vector angle is equal to $3\pi/4$ and the average magnetic vector is equal to 0.7 times the value of the vector along the direction of the magnetic field. The derivation was confirmed by an experiment in which the detecting element has two coils with the liquid flowing through them. It was found that indeed the maximum signal in one coil is obtained, as

a function of the oscillating field strength in that coil, when the signal amplitude in the second coil is 0.7 of its value when the field strength is zero. (TTT)

39736 SHIFT IN THE NUCLEAR RESONANCE SIGNAL FROM A FLOW-TYPE DETECTING ELEMENT. A. I. Zhernovoi and A. B. Rukhin. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 945-6(July 1963). (In Russian)

In a flow-type detecting element of a nuclear magnetic resonance apparatus a shift is produced in the detected signal which can lead to an error during the measurement and stabilization of the magnetic field. An examination was made to determine what happens to the vector of magnetizable nuclei in a liquid flowing through an oscillating magnetic field in a coil of a flow-type detecting element. It was found that when the gradient of the external magnetic field is aligned with the flow of the liquid that increasing the flow velocity or decreasing the oscillating magnetic field shifts the signal to the side of the strong field. Decreasing the flow velocity or increasing the oscillating field shifts the signal to the opposite side. When the direction of the gradient of the external field is reversed, i.e., opposite to the flow of the liquid, shifts in the signal are found to occur which are reversed to the ones listed. (TTT)

39737 ACCELERATION OF THE POLARIZATION OF NUCLEI IN A FLOW-TYPE NUCLEAR RESONANCE DETECTING ELEMENT. A. I. Zhernovoi, A. B. Rukhin, and O. V. Stakhov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 937-8 (July 1963). (In Russian)

To increase the polarization of a liquid flowing through a magnet the quantity V_1/qT, where V_1 is the magnetizing volume, q is the liquid current, and T is the nuclear relaxation time, can be increased. Also, the polarization can be raised by decreasing the quantity V_2/qT, where V_2 is the volume of the tube connecting the polarizer to the detecting element. Decreasing the magnetizing volume, however, increases the polarization capacity of the system. Thus if the volume can be decreased and still have the quantity V_1/qT remain large the acceleration of polarization can be achieved. This can be accomplished by decreasing the nuclear relaxation time in the flowing liquid. The relaxation time can be lowered by introducing impurities into the liquid. The relaxation time of protons in water flowing through iron filings or sand is 0.04 sec or 50 times less than the time in pure water. (TTT)

39738 CYCLOTRON RESONANCE IN SLIGHTLY IONIZED GASES. Fred C. Fehsenfeld (Univ. of Texas, Austin). J. Chem. Phys., 39: 1653-61(Oct. 1, 1963).

The conductivity of a slightly ionized gas in a uniform magnetic field was obtained from the solution of the Boltzmann equation for cases in which the collision frequency between electrons and neutral particles are dependent on the electron velocity. The line shapes of the cyclotron resonance absorption of energy from a high-frequency electric field and the derivative with respect to the magnetic field of the resonance absorption were computed. Also the relationship between the linewidth of the above curves and the collision frequency was obtained. The absorption of 9 kMc/sec microwave energy by the weakly ionized thermalized afterglows of helium, argon, oxygen, and carbon dioxide near cyclotron resonance was measured experimentally. From these measurements the collision frequencies for thermal electrons with He, Ar, O_2, and CO_2 were obtained. These collision frequencies are $2.0 + 0.2 \times 10^8$, $1.6 \pm 0.5 \times 10^8$, $1.7 \pm 0.2 \times 10^8$, and $24 + 2 \times 10^8$, respectively, for the above gases at 300°K and 1 mm Hg pressure. (auth)

39739 RADIAL LIMIT IN THE CONFIGURATION-INTERACTION METHOD FOR THE 1^1S STATE OF THE HELIUM ISOELECTRONIC SEQUENCE. H. L. Davis (Sandia Corp., Albuquerque, N. Mex.). J. Chem. Phys., 39: 1827-32(Oct. 1, 1963). (TID-18799; SCDC-3237)

Using the configuration-interaction method with only radial configurations, precise radial limits were obtained for the ground state of the helium isoelectronic sequence for atomic numbers 1 thru 20. All matrix elements required in the calculation are shown to be obtainable from sums over integers, which eliminates all necessity of any multiple precision arithmetic in the computer calculation. Also, when the atomic number is varied, considerable saving in computer time is achieved by noticing that all Hamiltonian matrix elements are expressible in the form $Z\eta A + \eta^2 B + \eta C$, where Z is the atomic number, η a nonlinear variational parameter, and A, B, and C are sums independent of Z and η. (auth)

39740 A SIMPLIFIED THEORY OF MAGNETOHYDRODYNAMIC ISOTROPIC TURBULENCE. R. Betchov (Aerospace Corp., El Segundo, Calif.). J. Fluid Mech., 17: 33-51(Sept. 1963).

The simplest case of turbulent motion in a conductive fluid is studied. The turbulence is assumed incompressible, isotropic, homogeneous, charge invariant, and free of fourth-order cumulants. The emphasis is placed on certain integrals of the correlation functions such as kinetic and magnetic energy, vorticity, and current. A system of nonlinear ordinary differential equations is derived, which governs these integral quantities. Several cases are solved numerically, illustrating the decay of ordinary turbulence, the buildup of magnetic energy by a linear or a nonlinear process, the buildup of kinetic energy, as well as the destruction of vorticity by Lorentz forces. In order to handle certain dissipative effects, a special hypothesis is introduced that seems to promote mathematical simplicity. In particular, it leads to a simple decay law very similar to the decay law of ordinary turbulence. (auth)

39741 A PHOTOMULTIPLIER INVESTIGATION OF THE LOW ENERGY CONTINUOUS X-RAY SPECTRUM. T. J. Peterson, Jr. and D. H. Tomboulian (Cornell Univ., Ithaca, N. Y.). J. Quant. Spectry. Radiative Transfer, 3: 285-7(July-Sept. 1963). (In English)

Observations were made on the intensity variation of the low-energy bremsstrahlung with target voltage (450 to 900 v). The photons with wavelengths from 173 to 193 A were diffracted onto the photomultiplier, and targets of Mg and Mn layers were used. The results are compared graphically with the shapes of the theoretical distributions; the comparison confirms Sommerfeld's theory in this energy range. (D.L.C.)

39742 SOME PROPERTIES OF DIELECTRIC CONSTANT AND PHONON FREQUENCY OF A SUPERCONDUCTOR. T. Nishiyama (Univ. of Maryland, College Park). Nuovo Cimento (10), 28: 1146-68(June 16, 1963). (In English)

The dielectric constant and the phonon frequency in a superconductor were investigated by means of Green's functions for the electronic and the total charge density fluctuation. Making use of the linearization approximation, the exact expressions for the electronic dielectric constant are obtained in both the high-frequency limit and the low-frequency limit. The proof of the sum rule formula given by Rickayzen was confirmed in the small-wave-number limit. The relation between the effective interaction between electrons and the dielectric constant was

examined by considering matrix elements of the density fluctuation between pair states. In the appendix, for a simplified effective interaction truncated in the neighborhood of the Fermi surface, the explicit expressions of the dielectric constant and the phonon frequency are obtained. The differences in the superconducting state from the values in the normal metal are pointed out using these expressions. Some vertices discarded in Rickayzen's theory give rise to a change in the location of a singularity to appear in the expression for the dielectric constant at a lower frequency than the characteristic frequency corresponding to the energy gap. There appears a change in the phonon frequency at very short wave lengths but no change appears in the sound velocity. (auth)

39743 PRESSURE SHIFT OF THE HIGH SERIES OF THE ALKALI METALS. T. Tietz (Univ. of Lodz, Poland). Nuovo Cimento (10), 28: 1509-11(June 16, 1963). (In English)

An approximate formula is obtained for the scattering length of the excited valence electron of the alkali metals. A form for the frequency shift of the electron, due to foreign atoms in the Bohr orbit, is given as $\Delta\nu = -a\hbar N/m$. (R.E.U.)

39744 FREE PATH IN NORMAL AND SUPERCONDUCTING STATES. P. Wyder (Eidgenössische Technische Hochschule, Zurich). Phys. Letters, 5: 301-2 (Aug. 1, 1963). (In German)

The free path was determined in samples of In in the normal and superconducting states using measurements of the heat resistance of wires of various diameters. The specific heat resistance was plotted as a function of 1/d (d is sample diameter) in the normal and superconducting states, from which l_n and l_s can be directly determined. The free paths in the normal and superconducting states agree, whereas the heat resistivity differs sharply from each other, especially at low temperatures. The free paths are equal both in the range of elastic contamination scattering and in the presence of inelastic phonon collisions. (J.S.R.)

39745 A DIRECT MEASUREMENT OF THE FOCUSING ENERGY FOR (110) COLLISION SEQUENCES IN GOLD. M. W. Thompson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Letters, 6: 24-6(Aug. 15, 1963). (In English)

The energy spectrum of atoms ejected along the (110) direction of a Au crystal under 40-kev Ar^+ ion bombardment was measured by a time-of-flight method. Ejection is attributed to the arrival at the surface of atomic collision cascades initiated by the ion bombardment, and these are mainly resolved into focused collision sequences along simple crystallographic rows. A precise value of the (110) focusing energy, which is the maximum with which (110) sequences can propagate, is obtained. The focusing energy is identified with a high energy cut-off in the spectrum at 280 ± 50 ev. An interatomic repulsion potential appears to be consistent with this result. (C.E.S.)

39746 ANALOGON OF BARKHAUSEN NOISE OBSERVED IN A SUPERCONDUCTOR. D. J. Van Ooijen and W. F. Druyvesteyn (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Phys. Letters, 6: 30-1(Aug. 15, 1963). (In English)

To investigate the mechanism of the destruction of superconductivity by a magnetic field, an experiment in which the field penetration is heard as a noise similar to that observed by Barkhausen during the magnetization of a soft ferromagnetic material was performed. A superconducting wire was surrounded by a pick-up coil and placed in a solenoid. Experiments were performed on soft annealed lead and lead-20.4 wt % indium wires. Explanations for the observed noise were presented. (C.E.S.)

39747 COMPLEX AC SUSCEPTIBILITY OF SOME SUPERCONDUCTING ALLOYS. M. Strongin and E. Maxwell (Massachusetts Inst. of Tech., Lexington). Phys. Letters, 6: 49-51(Aug. 15, 1963). (In English)

The amplitude and frequency dependence of the complex a-c susceptibility of superconducting alloys of Pb–Sn, Bi–Sn, Bi–In, and Sn–In were discussed. The strong dependence of the apparent transition temperature on the amplitude of the applied a-c field is illustrated. It is shown that increasing the frequency shifts the transition to higher temperatures. The effect of a superimposed d-c field on the a-c measuring field is also shown. (C.E.S.)

39748 ENERGY DISTRIBUTION OF TRAPPING CENTRES FOR HOLES IN ANTHRACENE. J. Adolph, E. Baldinger, W. Czaja, and I. Graenacher (Universität, Basel). Phys. Letters, 6: 137-9(Sept. 1, 1963). (In English)

The current-voltage characteristic and the time dependence of the current in an anthracene crystal with a 0.1 to 3 kv potential across it were measured. It was concluded that: the dark current does not reach a stationary value; there exists a trap-filled limit V_{TFL}; and for $V < V_{TFL}$ the current follows a power law relation with voltage over a large range. A model incorporating two trap levels was devised to describe the current time dependence, and the trap parameters were calculated. Effects of electrode materials on the measurements were investigated. (D.C.W.)

39749 BEHAVIOUR OF THE MAGNETISATION AND TRANSPORT CURRENT IN NbZr WIRE. M. A. R. LeBlanc (Stanford Univ., Calif. and Aerospace Corp., Los Angeles). Phys. Letters, 6: 140-3(Sept. 1, 1963). (In English)

The behavior of the magnetization and transport current in Nb–Zr wire in transverse fields was investigated. The hard superconductor model of Bean provides a qualitative understanding of the magnetization. Possible explanations for some phenomena associated with Nb–Zr solenoids are suggested by the data. Relations between the transport current, critical current, magnetization, field and current changes, etc., suggest the invalidity of pulsed field-pulsed current measurements of the critical current. (D.C.W.)

39750 FREE SPIN-WAVE THEORY RENORMALISED IN RESPECT OF TEMPERATURE. E. Praveczki (Central Research Inst. for Physics, Budapest). Phys. Letters, 6: 147-9(Sept. 1, 1963). (In English)

It is shown that the fundamental relations of the free spin-wave theory can be replaced by relations holding for ferromagnons with parameters renormalized with respect to temperature. Expressions for the internal energy, the free energy, and the partition function are given. The neutron scattering cross section formulas are also derived using Van Hove's formula relating the cross section to the spin correlation function. (D.C.W.)

39751 THE MÖSSBAUER EFFECT IN Te^{125}. E. P. Stepanov, K. P. Aleshin, R. A. Manapov, B. N. Samoilov, V. V. Sklyarevskii, and V. G. Stankevich (Kurchatov Inst. of Atomic Energy, Moscow). Phys. Letters, 6: 155-6 (Sept. 1, 1963). (In English)

The Mössbauer absorption spectra of Te^{125} 35.5-kev gamma rays in Te metal, amorphous Te, and TeO_2 were obtained using Pb–Te, the spectrum of which is an unsplit line. The spectra show marked asymmetry with different right to left intensity ratios for crystalline and amorphous Te. The amorphous and metallic Te spectra are resolvable

into two lines, in agreement with the quadrupole splitting of the $^3/_2$ level. Four lines due to two crystal modifications appear in the TeO_2 spectrum. The splittings for Te metal and oxide agree with Frankel's values. (D.C.W.)

39752 UNSPLIT ABSORPTION LINE OF Dy^{161} OF NATURAL WIDTH IN Dy_2O_3 AT $\underline{t}$ = 500°C. V. V. Sklyarevskii, K. P. Aleshin, V. D. Gorobchenco, I. I. Lukashevich, B. N. Samoilov, and E. P. Stepanov (Kurchatov Inst. of Atomic Energy, Moscow). Phys. Letters, 6: 157-8(Sept. 1, 1963). (In English)

The Mössbauer spectrum of Dy^{161} 26-kev gamma rays obtained with a Gd_2O_3 source at room temperature and a $Dy_2^{161}O_3$ absorber at 500°C indicates hyperfine splitting in the source and an unsplit line of natural width in the absorber. Heating the source to 500°C decreased the number of lines and narrowed the spectrum. The temperature dependence of a GdB_6-source spectrum full width revealed an abrupt change at 500°C showing the decrease of the number of lines by one-half. (D.C.W.)

39753 DAMPING OF THE LOW FREQUENCY MAGNETOPLASMA RESONANCE BY CYCLOTRON ABSORPTION IN SODIUM. M. T. Taylor, J. R. Merrill, and R. Bowers (Cornell Univ., Ithaca, N. Y.). Phys. Letters, 6: 159-61(Sept. 1, 1963). (In English)

The observation of Doppler shifted cyclotron resonance absorption of the magnetoplasma resonance in sodium plates is reported. The absorption was excited by a wave the frequency of which was five orders of magnitude less than the cyclotron frequency. The agreement between the observations and theory was investigated. (D.C.W.)

39754 ALTERNATING CURRENT LOSSES IN SUPERCONDUCTORS OF THE SECOND KIND. H. London (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Letters, 6: 162-5(Sept. 1, 1963). (In English)

The power (heating) losses occurring when an alternating current in a hard superconductor is used to produce a pulsed or alternating magnetic field are estimated. Heat losses for a solenoid are proportional to the conductor thickness, dictating the use of thin films for second-kind superconductors carrying alternating current. (D.C.W.)

39755 ANOMALOUS MAGNETOSTRICTION OF $Tb_3Fe_5O_{12}$ AND $Eu_3Fe_5O_{12}$. S. Iida (Tokyo, Univ.). Phys. Letters, 6: 165-7(Sept. 1, 1963). (In English)

Magnetostriction measurements were performed on (1 1 0) discs using a strain gauge technique. The magnetostriction constants λ_{100} and λ_{111} as a function of temperature show that for $Tb_3Fe_5O_{12}$ the λ_{111} is much larger than λ_{100}, while the inverse holds for $Eu_3Fe_5O_{12}$. Also, λ_{111} of $Tb_3Fe_5O_{12}$ proved to be quite large ($+5.6 \times 10^{-4}$ at liquid N temperature) and showed a rather sharp increase at low temperatures. The Tb^{3+} electronic level energy shift was calculated. A mechanism is proposed for the dissipation of microwave energy. (D.C.W.)

39756 FORMATION OF HYDROGEN NEGATIVE IONS IN MERCURY AND WATER VAPOURS. N. B. Brooks, M. Roos, R. P. Bastide, P. H. Rose, and A. B. Wittkower (High Voltage Engineering Corp., Burlington, Mass.). Phys. Letters, 6: 169-70(Sept. 1, 1963). (In English)

The equilibrium percentages of H^- ions in water and mercury vapors from incident H_1^+, H_2^+, and H_3^+ were measured as a function of beam energy. Higher conversion ratios were obtained in H_2O than in Hg or H (comparison only). The H^- yields at equilibrium target thickness appear to be ~ the number of protons in the dissociating molecule and to depend on proton energy. The dissociation of the molecular ions introduces an energy spread. An equilibrium target thickness of about 3×10^{15} atom/cm^2 was indicated. (D.C.W.)

39757 ON THE VALIDITY OF ONSAGER'S RECIPROCITY RELATIONS FOR STRONGLY COUPLED SYSTEMS. I. Prigogine and G. Severne (Université Libre, Brussels). Phys. Letters, 6: 173-4(Sept. 1, 1963). (In English)

Calculations on the heat flow and the diffusion in a binary isotopic mixture show that for strongly coupled systems in which the relaxation time is not very large with respect to the collision duration time Onsager's relation is not valid. (D.C.W.)

39758 ENERGY SPREADS FROM THE DISSOCIATION OF A MOLECULAR HYDROGEN ION BEAM. K. H. Purser, P. H. Rose, N. B. Brooks, R. P. Bastide, and A. B. Wittkower (High Voltage Engineering Corp., Burlington, Mass.). Phys. Letters, 6: 176-7(Sept. 1, 1963). (In English)

The energy spread of hydrogen ions produced by dissociation of H_1^+, H_2^+, and H_3^+ was measured as a function of incident beam energy. The results show that the initial atomic beam must be used to minimize the energy spread in the ion beam produced. (D.C.W.)

39759 THE GENERAL THEORY OF TRANSPORT PROCESSES AND THE CORRELATION FUNCTION METHOD. I. Prigogine and G. Severne (Université, Libre, Brussels). Phys. Letters, 6: 177-9(Sept. 1, 1963). (In English)

A general formulation valid to an arbitrary order in the coupling constant or concentration was developed for thermal disturbances involving transport processes in systems with non-uniform thermodynamical parameters. Viscosity calculations indicate that for thermal disturbances Kubo's formula is valid only to the lowest order. (D.C.W.)

39760 ELECTRONS IN LIQUID METALS BY POSITRON ANNIHILATION. A. T. Stewart (Univ. of North Carolina, Chapel Hill), J. H. Kusmiss, and R. H. March. Phys. Rev., 132: 495-7(Oct. 15, 1963).

The angular correlation of photons from positrons annihilating in solid and liquid Na, Ga, In, and Sn was measured. The results are interpreted in terms of a mean free path of the conduction electrons. These mean free paths are compatible with values derived from electrical conductivity measurements except for Ga which shows anomalous behavior. (auth)

39761 CHEMICAL POTENTIAL AND LOW-LYING EXCITATIONS IN THE MANY-BOSON SYSTEM. [PART] II. Ludwig W. Bruch and Katuro Sawada (Univ. of California, San Diego). Phys. Rev., 132: 499-504(Oct. 15, 1963).

The approximate description of a many-boson system by its density fluctuations is considered. The representation of the chemical potential by a scattering matrix is compared with an exact solution in one dimension. It is found to be valid exactly in the low coupling limit and valid to within 10% for intermediate coupling strengths. In the case treated, the ground-state properties are given quite accurately for intermediate coupling strengths. The excitation spectrum is described less accurately. The velocity of sound obtained from the slope of the phonon spectrum is formally different from that obtained using the compressibility. Here, the sound velocities obtained from the two methods are found to agree numerically. Data for actual He^4 and a simple linear approximation to the density dependence of the scattering matrix are used. The sound velocity obtained is in rough agreement with the experimentally observed velocity in liquid He^4. (auth)

39762 PROPERTIES OF A THIN HOLLOW SUPERCONDUCTING CYLINDER. D. H. Douglass, Jr. (Univ. of Chicago). Phys. Rev., 132: 513-21(Oct. 15, 1963).

The properties of a thin, superconducting cylindrical tube are considered by means of the Ginsburg-Landau theory. The equations were solved under the condition that the magnitude of the energy gap is independent of position but not independent of magnetic field H_0 or of fluxoid quantum number n. This latter dependence on H_0 and n, which is usually ignored, is found to lead to modification of the expressions for the various superconducting properties. In the limit $rd/\lambda^2 \leq 1$, where r is the radius, d the thickness, and λ the penetration depth, the energy gap goes smoothly to zero with magnetic field for a fixed n, defining a second-order phase transition. The magnetization, the current density, and the free energy also go smoothly to zero, with the curves for different n being displaced by n times the field corresponding to unit quantum. For this case the transition temperature is periodic with magnetic field with period corresponding to unit quantum, which agree with the experiments of Little and Parks and the calculation of Tinkham. In the limit $rd \geq \lambda^2$, the energy gap drops discontinuously to zero at critical conditions, giving a first-order phase transition, with a corresponding influence on the other properties of the superconductor; also the possibility of a thermodynamically metastable region with respect to the normal state arises. In order to obtain agreement with the measurements of critical persistent currents and the measurements of flux quantization, it must be assumed that n is a good quantum number under any conditions as long as the system remains superconducting. This leads to metastable states that for the $rd \geq \lambda^2$ case includes states that are thermodynamically metastable as well. (auth)

39763 METHOD OF CALCULATING THE ENERGY LEVELS OF TRAPPED ELECTRONS IN IONIC CRYSTALS. Shao-fu Wang (Univ. of Illinois, Urbana). Phys. Rev., 132: 573-7(Oct. 15, 1963).

Starting from a many-body formulation that includes the phonon field, a method of calculating the energy levels of an electron trapped at a defect in an ionic crystal is developed. Detailed calculations for the F center are given. The higher excited states of the F center and the K absorption bands are also discussed. (auth)

39764 FIELD AND ANGULAR DEPENDENCE OF CRITICAL CURRENTS IN Nb_3Sn. G. W. Cullen (RCA Labs., Princeton, N. J.), G. D. Cody, and J. P. McEvoy, Jr. Phys. Rev., 132: 577-80(Oct. 15, 1963).

Measurements were made on the critical current of Nb_3Sn vapor-deposited strips on ceramic material. The Nb_3Sn was obtained from vapor deposition and is single phase without any preferred orientation in the plane of the strip. Critical currents were obtained at 4.2°K as a function of field up to 20,000 G, and as a function of the angle between the field and the current axis. Below 10,000 G a sharp rise in critical current by about a factor of two was observed for longitudinal fields, and a gradual decrease in critical current for transverse fields. Above 10,000 G the field and angular dependence is in good agreement with the predictions of the Lorentz force model of Kim et al. Below 10,000 G, the field dependence can be associated with a transition from an inhomogeneous to homogeneous current distribution with consequent lower local critical current densities. Experimental results are also reported for field shielding measurements on similar material in cylindrical form. Excellent agreement is obtained in both magnitude and field dependence with the strip data. (auth)

39765 NUCLEAR POLARIZATION IN HOMOGENEOUS InSb BY A DIRECT CURRENT. M. Weger (Univ. of California, San Diego). Phys. Rev., 132: 581-8(Oct. 15, 1963).

Clark and Feher showed that an electric field applied to InSb in a constant magnetic field produces nuclear polarization. Two mechanisms are suggested here to account for nuclear polarizations in homogeneous samples. In one mechanism, the kinetic temperatures of spin up and spin down electron distributions, θ_R^+ and θ_R^-, are assumed to be different. It is shown that a nuclear polarization of order $N^+/N^- \approx [\tau_N(\theta_R^-)/\tau_N(\theta_R^+)][\tau_\epsilon(\theta_R^+)/\tau_\epsilon(\theta_R^-)]$ may be produced in this case. τ_N and τ_ϵ are the nuclear and electronic longitudinal relaxation times (T_1's). In the second mechanism, the momentum distribution is assumed to be displaced by an amount Δp due to the applied electric field. A nuclear polarization of order $\Delta p^2/2m^*E_F$ may be induced in this case. It is suggested that a sizable fraction of the nuclear polarization observed by Clark and Feher is due to the first of these mechanisms. (auth)

39766 GAP EQUATION AND CURRENT DENSITY FOR A SUPERCONDUCTOR IN A SLOWLY VARYING STATIC MAGNETIC FIELD. Ludwig Tewordt (Univ. of Notre Dame, Ind.). Phys. Rev., 132: 595-600(Oct. 15, 1963).

The energy gap equation and the current density expression for a superconductor in a slowly varying static magnetic field are derived on the basis of a generalization of Nambu's Green's function formalism to finite temperatures. In the integral equation for the quasiparticle Green's function $G^A(R;r)$, expansions of G^A, the self-energy part Σ, and the vector potential A, about the center-of-mass coordinates R, are introduced. The integral equation is solved by iteration, and the contributions of all orders in the gap $\phi(R)$ are summed. With the help of G^A, the generalized Ginzburg-Landau-Gor'kov (GLG) equations, valid at all temperatures for slowly varying A(R) and $\phi(R)$ are derived. For temperatures near T_c, correction terms to the coefficients of the GLG equations occur that are proportional to powers of $|\beta\phi|^2$. For temperatures near 0°K, the function multiplying the term $(\nabla + 2ieA)^2\phi$ behaves like $\exp(-|\beta\phi|)$. The first-order correction to the term proportional to A^2 is found to be proportional to $\xi_0^2H^2$, for T near T_c and near 0°K (H = magnetic field strength, ξ_0 = coherence length). The results are consistent with the formula of Nambu and Tuan for the reduction of the gap at 0°K in the London region. (auth)

39767 ULTRASONIC ABSORPTION BY SUPERCONDUCTING Nb–Zr ALLOYS. Lewis T. Claiborne and Norman G. Einspruch (Texas Instruments Incorporated, Dallas). Phys. Rev., 132: 621-9(Oct. 15, 1963).

Ultrasonic attenuation studies in dilute superconducting Nb–Zr alloys revealed strongly temperature-dependent absorption peaks that cannot be explained in terms of single electron-phonon scattering processes. The set of temperatures at which these peaks occur is dependent on the frequency of the sound wave and the strain content of the sample. A phenomenological model is proposed that interprets the absorption peaks as being due to an exchange of energy that occurs when the sound frequency is equal to one of a set of collective excitation modes of the electron gas. The assumptions on which the model is based are the same as those that yield collective excitations within the energy gap in more fundamental descriptions of the superconducting state. The phenomenological treatment involves a hydrodynamic approach in a finite superconducting phase, based on volume derivatives of the electronic free energy under conditions of charge neutrality. The interaction constant

for the collective excitations is empirically assumed to be decreased by the factor, $\chi(r_0) \equiv \xi^{-1} r_0 \exp(\alpha - \xi r_0^{-1})$, when the extent of the superconducting phase r_0 is less than the coherence distance ξ. Good agreement between the experimental data and the results of the proposed model is obtained. (auth)

39768 INTERPRETATION OF DEBYE-WALLER FACTORS. J. L. Feldman and G. K. Horton (Rutgers Univ., New Brunswick, N. J.). Phys. Rev., 132: 644-7(Oct. 15, 1963).

The Debye-Waller factor, $\Theta^{DW}(T)$, calculated in the quasiharmonic approximation from thermodynamic data, is compared with the results of the Mössbauer experiment on tin of Boyle et al.; the difference between the curves increases with temperature and is significant. Boyle et al. interpreted their results as showing substantial anharmonic effects and suggested that this interpretation was reasonable by appealing to a model involving a single particle in a one dimensional well. Their model was applied to a number of other elements, especially copper, germanium, and silicon, and the Debye-Waller data were found to be consistent with the calorimetric data only for tin. It is concluded that the very simplified model of Boyle et al. may be unreliable. The Mössbauer results of Wiedemann et al. and Yaqub and Höhenemser are considered. In view of the reliability of calorimetric data and the experimental difficulties involved in making Mössbauer measurements it is felt that Wiedemann's value of 153°K for Θ_0^{DW} is high by about 7%. The results of Yaqub and Hohenemser agree quite well with obtained results. They have apparently observed no evidence of vibrational anharmonicity in tin even at their highest temperature reading of 373°K. (auth)

39769 THEORY OF A LOCAL SUPERCONDUCTOR IN A MAGNETIC FIELD. N. R. Werthamer (Bell Telephone Lab., Murray Hill, N. J.). Phys. Rev., 132: 663-8(Oct. 15, 1963).

The behavior of a superconductor in a static magnetic field H(r) is considered in the limit that the field and the gap function $\Delta(r)$ vary slowly in space compared with the correlation distance of a superconducting electron pair (local limit). The superconductor is described by a pair of coupled differential equations for $\Delta(r)$ and the induced vector potential A(r). The equations are analogous in form to those proposed phenomenologically by Ginzburg and Landau (GL), but contain additional nonlinear terms. When Δ is independent of position and H is weak, the equations reduce to those given by BCS for the dependence of Δ and the penetration depth on the temperature T. When $\Delta \ll T$, the equations reduce to those derived by Gor'kov, in confirmation of the GL theory. The region of validity of the derivation is examined, showing that while a local electrodynamics can be correct for some materials over a wide range of T and H, $\Delta(r)$ is slowly varying for $T \ll T_c$ only if Δ is near to its equilibrium, zero-field value. (auth)

39770 EXCITATION OF THE He II λ4686 Å LINE BY ELECTRON IMPACT. R. H. Hughes and L. D. Weaver (Univ. of Arkansas, Fayetteville). Phys. Rev., 132: 710-11(Oct. 15, 1963).

Absolute cross sections for the excitation of the HeII λ4686 Å line by electron impact on helium were measured as a function of electron energy from threshold to 400 ev. A rough comparison of the results is made with expected cross sections from the calculations of Dalgarno and McDowell. Excitation of the HeI λ4713 Å line ($4\,^3S - 2\,^3P$ transition) was also measured and the results compared with those of other investigators. (auth)

39771 STUDY OF THE SPIN-RELAXATION TIMES AND THE EFFECTS OF SPIN-EXCHANGE COLLISIONS IN AN OPTICALLY ORIENTED SODIUM VAPOR. L. Wilmer Anderson and Alan T. Ramsey (Univ. of Wisconsin, Madison). Phys. Rev., 132: 712-23(Oct. 15, 1963).

The spin-relaxation time of an optically oriented sodium vapor diffusing in a helium or neon buffer gas was measured and analyzed by the method of Franzen. The diffusion coefficients for sodium in helium and neon are 1.0 ± 0.3 and 0.50 ± 0.17 cm^2/sec, respectively. The disorientation cross sections for sodium colliding with helium and neon are $(3 \pm 4) \times 10^{-26}$ and $(1.8 \pm 0.6) \times 10^{-24}$ cm^2, respectively. The radio-frequency Zeeman transitions of the sodium atoms in the ground state were examined. An analysis of the effects of spin-exchange collisions between sodium atoms on the intensities and line shapes of the various Zeeman transitions is presented. From these studies a spin exchange cross section of $(1-3) \times 10^{-14}$ cm^2 is estimated for two sodium atoms colliding. The main source of error in this measurement is probably lack of knowledge of the sodium vapor pressure in the sodium-absorption cells. (auth)

39772 MEASUREMENT OF THE ATOMIC SCATTERING FACTOR OF Ne, Ar, Kr, AND Xe. D. R. Chipman and L. D. Jennings (U. S. Army Materials Research Agency, Watertown, Mass.). Phys. Rev., 132: 728-34(Oct. 15, 1963).

To test the accuracy of the Hartree-Fock (HF) method and the reliability of x-ray measurements of the atomic scattering factor f, the scattering of Mo Kα radiation by Ne, Ar, Kr, and Xe gases was determined. Values of f were obtained on an absolute basis with an accuracy of about ¼%. Results at small angle yield the mean-square radius of the electron cloud $(r^2)_{av}$ and the dispersion correction. For Ne, Ar, and Kr, the values of $(r^2)_{av}$ are in good agreement with HF calculations. For Xe, the experimental value is significantly lower. Susceptibility results yield about 6% lower values in each case. The derived values of the dispersion correction are each more negative than those obtained from published absorption coefficients. At higher angles, the f values differ by less than 0.2 electron unit from the HF values for all the gases; even for Xe the approximate HF values presently available are more nearly accurate than the Thomas-Fermi-Dirac (TFD) values. It is concluded that a 4% discrepancy between theory and experiment found by Batterman, Chipman, and DeMarco for metal powders arose from solid-state effects or from difficulties in sample preparation. (auth)

39773 Z EXPANSION OF HARTREE-FOCK WAVE FUNCTIONS. David Layzer (Harvard Coll. Observatory, Cambridge, Mass.). Phys. Rev., 132: 735-7(Oct. 15, 1963).

Let a many-electron Hartree-Fock radial function $\Phi^{HF}(nl;r) = \Pi_{i=1}^{N} P^{HF}(n^i l^i; r_i)$ and the corresponding nonseparable variational function $\Phi(nl;r)$ be expanded in hydrogenic product functions $\Phi^H(nl;r)$. The expansion coefficients $(Hn'l'|nl)$ of Φ are $O(Z^{-1})$ for $n' \neq n$; they vanish when the sets n,n' differ by more than two one-electron quantum numbers. It is shown that the expansion coefficients $(Hn'l'|HFn)$ are $O(Z^{-2})$ when $\nu(n,n') = N - \Sigma_{i=1}^{N} \delta(n^i n^{i'}) = 2$, i.e., when n and n' differ in two places, and are $O(Z^{-1})$ when $\nu(n,n') = 1$. In the second case $(Hn'l'|HFnl) = (Hn'l'|nl) + O(Z^{-2})$; the Hartree-Fock and the nonseparable expansion coefficients coincide to first order. This result holds only if the one-electron Hartree-Fock functions P^{HF} are not restricted by auxiliary conditions other than normalization. It does not hold, for example, if one requires the P^{HF} to

satisfy the orthogonality condition $(P^{HF}(nl;r)P^{HF}(n'l;r)) = \delta(n,n')$. From the result just stated, it follows that many-electron Hartree-Fock functions characterized by distinct sets of principal quantum numbers but the same set of azimuthal quantum numbers are orthogonal to first order in Z^{-1} (but not to higher orders). It also follows from the stated result that the coefficient W_0 in the Z expansion $W^{HF} = W_2Z^2 + W_1Z + W_0 + O(Z^{-1})$ of a Hartree-Fock energy is given (in atomic units) by the formula

$$W_0 = \sum_{\kappa(n,n')\neq 1} \frac{|(Hn|V|Hn')|^2}{W_2 - W_2'}, \quad W_2 = -\sum_{i=1}^{N} \frac{1}{2n^{i2}},$$

where V is the mutual electrostatic interaction of the electrons. (auth)

39774 SCATTERING OF VERY INTENSE ELECTROMAGNETIC WAVES. Masataka Mizushima (Univ. of Colorado, Boulder). Phys. Rev., 132: 951-4(Oct. 15, 1963).

The conventional dispersion formula for the scattering cross section of light is extended to include the case of a very high intensity light. The resulting formula predicts an appreciable decrease of the cross section compared to the conventional theory, as the intensity of the light increases. The decrease appears when the energy density of the light becomes comparable to $[\hbar(\omega_0-\omega)/M]^2\epsilon_0$, where ω_0 is the resonance frequency of the scattering medium, ω is the frequency of the light, M is the transition dipole moment, and ϵ_0 is the capacitivity of the vacuum. In a typical case, this means about 10^{10} W/cm^2 of the light intensity is needed, which is obtainable with a focused optical maser. (auth)

39775 THERMO-PHOTO-VOLTAIC ENERGY CONVERSION. Bruce D. Wedlock (Massachusetts Inst. of Tech., Cambridge). Proc. IEEE (Inst. Elec. Electron. Engrs.), 51: 694-8(May 1963).

The concept of a thermo-photo-voltaic (TPV) energy converter is introduced and the device compared with thermoelectric and thermionic converters. Features of the TPV converter are that the entire device is kept at room temperature; potential power densities on the order of 10 w/cm^2, and potential conversion efficiencies of 30 per cent are possible. Considerations for TPV converter design are presented and compared with solar cells. Use of geometry and thin-film optical filters to improve efficiency is discussed. For a germanium converter operating with a hot source in the neighborhood of 1600°C a p-i-n structure with the absorption taking place in the intrinsic base region is shown to give maximum efficiency. A measured efficiency of 4.23 per cent on an experimental converter with 282 mw/cm^2 incident energy was achieved. (auth)

39776 TRANSPORT EFFECTS IN CESIUM THERMIONIC CONVERTERS. George N. Hatsopoulos (Thermo Electron Engineering Corp., Waltham, Mass.). Proc. IEEE (Inst. Elec. Electron. Engrs.), 51: 725-33(May 1963).

One of the primary reasons for the failure of thermionic converters to attain their ultimate theoretical performance is electron transport effects occurring in the interelectrode spacing. Two major types of transport effects, electron scattering and electron space charge, are discussed, and theoretical results are compared with experimental data. The uniform plasma theory is reviewed, and experimental data show that for a monocrystal emitter this theory is consistent with the energy equation. Space charge neutralization is discussed. Both surface ionization and volume ionization are considered. Experimental results indicate that surface ionization is not as effective as would be expected by theory. This fact is responsible for the discrepancy between theoretically expected and experimentally obtained performance of converters. Under the conditions where surface ionization is inadequate for space charge neutralization, volume ionization can provide the necessary ions. Volume ionization, however, is achieved at the expense of the output power of the converter. (auth)

39777 EMISSION PHYSICS OF THE THERMIONIC ENERGY CONVERTER. N. S. Rasor (Thermo Electron Engineering Corp., Waltham, Mass.). Proc. IEEE (Inst. Elec. Electron. Engrs.), 51: 733-47(May 1963).

Emission processes establish the upper limit of the performance obtainable in the thermionic converter. The basic factors are introduced that must be considered to achieve this limit and recent developments in the related technology are outlined. The basic elements of thermal excitation common to these processes are outlined and the results are used to illustrate the interdependence of the atom, electron and ion emission processes. The constraints imposed by this interdependence imply the existence of a natural limitation on vaporization lifetime for efficient operation using elementary emitter materials. This limitation is overcome by the use of emitters with an adsorbed layer of cesium and constraints imposed by the interdependence of the emission processes prescribe regions of efficient operation of these emitters. Consideration of the basic processes occurring in the adsorbed layer permits semiquantitative evaluation of the relative merit of different materials for use as emitters and collectors. The effect of nonuniform surfaces is reviewed and work in progress to understand the nature and origin of the nonuniformities is discussed. Substantial improvement in converter performance and reproducibility is possible through the development of uniform and optimum electrode surfaces. (auth)

39778 ANALYSIS OF THE ARC MODE OPERATION OF THE CESIUM VAPOR THERMIONIC ENERGY CONVERTER. K. G. Hernqvist (RCA Labs., Princeton, N. J.). Proc. IEEE (Inst. Elec. Electron. Engrs.), 51: 748-54 (May 1963).

An analysis of the cesium vapor arc discharge is presented. It is assumed that the discharge operates in the ball-of-fire mode, that cumulative ionization via the two resonance excited states is the predominant ionization mechanism, and that trapping in the plasma of the resonance radiation results in a long effective lifetime of the excited states. A volt-ampere characteristic is derived for the cesium arc and the results are applied to the thermionic energy converter. Good qualitative agreement is obtained between theory and experiment. (auth)

39779 RADIO-FREQUENCY OSCILLATIONS IN THERMIONIC DIODES. R. J. Zollweg and M. Gottlieb (Westinghouse Research Labs., Pittsburgh). Proc. IEEE (Inst. Elec. Electron. Engrs.), 51: 754-9(May 1963).

Radio-frequency oscillations are observed in alkali vapor-filled thermionic diodes at low vapor pressure. A review of the experimental phenomena and attempts at quantitative theoretical understanding is given. Possible applications are for energy conversion and as a diagnostic tool. (auth)

39780 EFFECT OF ANODE EMISSION OF ELECTRONS ON SPACE-CHARGE THEORY OF THE PLASMA THERMIONIC CONVERTER. Robert G. McIntyre (Texas Instruments Inc., Dallas). Proc. IEEE (Inst. Elec. Electron. Engrs.), 51: 760-8(May 1963).

The space-charge potential theory in low-pressure

thermionic converters is extended to cover emission of electrons at the anode as well as both ion and electron production at the cathode. The contribution of each of these three sources to the charge density is expressed as a function of potential for the ten most important cases. The first integrations of Poisson's equation are given for each of the cases. Previous analytical work reporting first integrations of Poisson's equation without anode emission appears as a special case. In addition, in each of the ten first-order differential equations there appears a term giving the contribution of anode emission. As before, analytical solution of the first-order differential equations is impossible. For illustrative purposes numerical solutions were obtained on the IBM 704 computer. Comparison with previous numerical solutions show the effect of anode emission on the space-charge potential in the diode. Also shown in figures is the effect of the variation of parameters for certain selected cases. (auth)

39781 SOME CHARACTERISTICS OF A CESIUM PLASMA CELL. M. Kihara, S. Ono, Y. Shibata, and Y. Koike (Tohoku Univ., Sendai). Proc. IEEE (Inst. Elec. Electron. Engrs.), 51: 769-73(May 1963).

Many studies about cesium plasma cells have been reported, but it seemed that there were few in which one could combine experimental results with theoretical ones in the sense that these experimental studies were carried out only in an operating region of almost constant cathode work function, that is, considerably high cathode temperatures. Our measurements were done only in the region of low cathode temperature and low gas pressure in which the interelectrode spacing was less than the mean free path of electrons, in order to examine these theories. The efficiency agreed well with one of these theories. Open-circuit voltage was also observed. (auth)

39782 THE EFFECTIVE COLLISION FREQUENCY IN MOLECULAR HYDROGEN IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. S. C. Haydon and A. G. Robertson (Univ. of New England, Armidale, N.S.W., Australia). Proc. Phys. Soc. (London), 82: 343-52(Sept. 1, 1963).

The effective electron collision frequency ν is evaluated for hydrogen from pre-breakdown ionization measurements in crossed electric and magnetic fields. A constant value $\nu = 2.5 \times 10^9 p\ sec^{-1}$ is obtained for all values of the parameters $100 < E/p < 250$ v cm^{-1} $mmHg^{-1}$ and $0 < H/p < 300$ OemmHg^{-1} in agreement with the basic assumption underlying the formulation of an equivalent pressure concept for the influence of a transverse magnetic field in hydrogen. An error analysis is used to illustrate the problems associated with a determination of accurate values of ν at low values of E/p in the presence of small magnetic fields. (auth)

39783 SOME CHARGE EXCHANGE AND DISSOCIATION COLLISIONS OF N_2^+ IONS. W. McGowan and L. Kerwin (Laval Univ., Quebec). Proc. Phys. Soc. (London), 82: 357-67(Sept. 1, 1963).

The formation of an N^+ ion beam can be accompanied by the formation of N_2^{2+}. When collision processes involving N^+ are studied, the N_2^{+2} can also enter into a variety of reactions with quite large cross sections, which introduce large errors in the cross sections associated with the N^+ processes. Data are given for the N_2^{+2} content in the ion beam coming from the typical electron impact source; cross sections are measured for the N_2^{+2} collision in N_2 through the energy range 1.2 to 4.0 kev. Assuming that the majority of N_2^{+2} ions are in their ground state at the time of collision, a set of most probable reactions are chosen which best fit the data. They are

$$N_2^{2+}(x^3\Pi_u) \text{ coll } N_2(x^1\Sigma_g) = N_2^+(x\ ^2\Sigma_g^+) + N^+(^3P) + N(^2D)$$
$$= N^+(^3P) + N(^2D) + N_2^+(x\ ^2\Sigma_g^+)$$
$$= N_2(x\ ^1\Sigma_g) + N_2^{2+}(x\ ^3\Pi_u).$$

The effects of these reactions on previously measured cross sections for N^+ in various gases are discussed. (auth)

39784 A MEASUREMENT OF THE CROSS SECTION FOR THE IONIZATION OF N^+ TO N^{2+} BY ELECTRON IMPACT. M. F. A. Harrison, K. T. Dolder, and P. C. Thonemann (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Phys. Soc. (London), 82: 368-71 (Sept. 1, 1963).

A crossed electron and ion beam method was used to measure the cross section for ionization of N^+ to N^{+2} by electrons with energies in the range 20 to 500 ev. The cross section rises from the threshold to a maximum value of 5.0×10^{-7} cm^2 at an electron energy of 125 ev. The error in the measured cross section are uncertain because of an apparent cross section below threshold attributed to the electron impact dissociation of N_2^{+2}. (auth)

39785 CROSS SECTIONS FOR ELECTRON-HYDROGEN ATOM COLLISIONS IN THE BORN APPROXIMATION TO THE REACTANCE MATRIX. W. B. Somerville (Univ. of London). Proc. Phys. Soc. (London), 82: 446-55(Sept. 1, 1963).

Born partial wave integrals were evaluated for all transitions induced by electron impact between the hydrogen atom states 1s, 2s, 2p, 3s, 3p, and 3d. These form the Born reactance matrix R_B. Calculations were performed for $k_1 = 1.0$, 1.2, 1.5, and 2.0 with 13.6 k_1^2 ev being the energy associated with the 1s state, and cross sections determined from the transmission matrix T obtained in the conventional first Born approximation, $T_I = -2iR_B$, and also in the Born approximation II, $T_{II} = -2iR_B/(1 - iR_B)$, which takes some account of couplings between the various states considered. Introducing couplings to the n = 3 states in the approximation II calculations has altered only to a small extent the cross sections involving the states 1s, 2s, and 2p only, compared with results obtained by Burke and Seaton. (auth)

39786 THE BACK-SCATTERING OF ELECTRONS FROM SOLIDS. S. G. Tomlin (Univ. of Adelaide, South Australia). Proc. Phys. Soc. (London), 82: 465-6(Sept. 1, 1963).

Archard's diffusion model of electron back-scattering is discussed on the basis of a result obtained by Tomlin and Metchnik in 1963 in their treatment of x-ray emission intensities. The resulting simple formula for the back-scattering coefficient is in reasonably good agreement with measured values. (auth)

39787 INTERNAL MÖSSBAUER-EFFECT IN ^{57}Fe. H. Hoegåsen (Norwegian Defence Research Establishment, [Oslo]), K. Bergheim, and K. Skarsvåg. Phys. Norvegica, 1: 153-6(1963). (In English)

The structure of the decay of the 14-kev level in Fe^{57} was studied by delayed coincidence measurements for excited Fe^{57} nuclei bound in crystals of different thicknesses and temperatures. The data agree with earlier measurements, except for short times. (auth)

39788 THE CONSERVATION LAWS OF PHYSICS. Gerald Feinberg and Maurice Goldhaber. Sci. Am., 209: 36-45(Oct. 1963).

The great power of the conservation laws is shown by

simple experiments carried out in the realm of elementary-particle processes. These laboratory tests validate the laws to unprecedented limits of accuracy. (R.E.U.)

39789 SUPERCONDUCTIVITY OF DILUTE PRIMARY SOLID SOLUTIONS OF In–Mg AND In–Pb. Yasukuni Ohtsuka, Yoshio Shibuya, and Tadao Fukuroi. Sci. Rept. Res. Inst., Tohoku Univ., Ser. A, 15: 67-77(Apr. 1963).

By measuring magnetic moments and electrical resistances of pure indium and indium alloys containing 0.28 to 13.7 atomic per cent magnesium and 0.06 to 0.73 atomic per cent lead at liquid helium temperatures, the variation of the superconducting critical temperature, T_c with the concentration of solute metals was studied. T_c decreases initially with the increasing concentration of solute in so far as a small amount of solute metals is concerned. When the amount becomes large, the alloying effect of magnesium differs from that of lead, i.e., in the former case T_c continues to decrease steadily, while in the latter it shows a gradual increase after passing through a minimum. These results qualitatively agree with the theoretical consideration of Anderson and of Nakamura. The threshold magnetic field at 0°K and the coefficient of electronic specific heat in the normal state were estimated from the data obtained. (auth)

39790 LAYER STRUCTURE SUPERCONDUCTOR. E. Revolinsky, E. P. Lautenschlager, and C. H. Armitage (Allis-Chalmers Research Labs., Milwaukee). Solid State Commun., 1: 59-61(Aug. 1963). (In English)

The superconducting properties of $NbSe_2$ are investigated because of its layer-like structure. The zero-field transition temperature was found to be 5.15 to 5.62°K. (R.E.U.)

39791 CALCULATION OF RADIATIONLESS TRANSITION PROBABILITY FOR THE Sm^{2+} ION IN FLUORITE. B. Z. Malkin (Kazan State Univ., USSR). Soviet Phys.-Solid State (English Transl.), 5: 773-6(Oct. 1963).

A calculation was made of the probability of the radiationless two-phonon transition $^7F_1 \rightarrow {}^7F_0$ for an Sm^{2+} ion in a cubic environment consisting of the F^- ions in the fluorite structure, the transition occurring during laser operation in a $CaF_2:Sm^{2+}$ crystal. The relaxation width obtained for the $^7F_1$ level was compared with the width of the luminescence line 7083 A corresponding with electrical dipole transition to this level. (auth)

39792 DETERMINATION OF ESCAPE DEPTH AND YIELD OF TRULY SECONDARY ELECTRONS FROM EXPERIMENTAL DATA OF X-RAY PHOTOEMISSION ENERGY SPECTRUM. V. N. Shchemelev, M. A. Rumsh, and E. P. Denisov (Leningrad State Univ.). Soviet Phys.-Solid State (English Transl.), 5: 827-30(Oct. 1963).

The thickness of the zone from which truly secondary electrons are emitted (the escape depth) and the yield of the electrons for NaCl, KCl, and KBr, were determined. The determination is based on an analysis of the energy spectrum of x-ray photoemission. (auth)

39793 THE ENERGY DISTRIBUTION OF CURRENT CARRIERS IN A SEMICONDUCTOR IN THE PRESENCE OF SOURCES OF FAST ELECTRONS. Yu. M. Popov (Lebedev Inst. of Physics, Leningrad). Soviet Phys.-Solid State (English Transl.), 5: 855-7(Oct. 1963).

The distribution function for the nonequilibrium current carriers in a semiconductor was found for the case in which the exciting source produces current carriers with an energy that is a large multiple of the thermal energy. At energies much smaller than that of the carriers produced by the external excitation, the distribution function is a Boltzmann function plus a small correction term that makes the distribution function differ from the Boltzmann form at large energies. The case considered is that of a small density of nonequilibrium carriers, in which the most important effect is that of collisions with the lattice, and it is shown that in this case, under stationary conditions, it is impossible to obtain an inversion of the probabilities between any two levels belonging to a single band. (auth)

39794 EFFECT OF ANHARMONICITY ON THE TEMPERATURE SHIFT IN THE MÖSSBAUER EFFECT. E. M. Iolin (Inst. of Physics, Riga). Soviet Phys.-Solid State (English Transl.), 5: 872-4(Oct. 1963).

In the harmonic approximation the temperature derivative of the temperature shift is expressed in terms of the heat capacity of the crystal, which is assumed to be ideal. The violation of this relation as produced by anharmonicities of the third and fourth orders was considered. The limiting cases of high and low temperatures are discussed. (auth)

39795 ELECTRON PARAMAGNETIC RESONANCE OF Tm^{2+} IN CaF_2. P. P. Pashinin, A. M. Prokhorov, and V. T. Udovenchik (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Solid State (English Transl.), 5: 891-2(Oct. 1963).

The spectrum of Tm^{2+} in CaF_2 consists of two lines of superfine structure separated by 228.8 ± 0.3 Oe, and the positions of the lines are independent of the direction of the magnetic field. With third-order correction it was found that the constant of the superfine structure for Tm^{169} is $\tilde{A} = (367.5 \pm 0.5) \times 10^{-4}$ cm^{-1}, and the g-factor is $g = 3.452 \pm 0.002$, a value very close to the theoretical value: $g = 3g_J = 24/7$. The nuclear magnetic resonance of Tm^{169} was determined to be $\mu_I(Tm^{169}) = -0.193 \pm 0.003$. (P.C.H.)

39796 DIFFERENTIATION BETWEEN THE ATOM AND ION SPECTRA OF SOME RARE EARTHS USING ONLY A d.c. ARC AS EXCITATION SOURCE. S. Held (Soreq Research Establishment, Israel). Spectrochim. Acta, 19: 1615-16(Sept. 1963). (IA-812). (In English)

A method is given for distinguishing between the atom and ion spectra of Nd using only a d-c arc as excitation source. Changes of relative intensities of the atom and ion lines appear as a result of different temperatures of the arc plasma in the first and second period of burning of the sample mixed with K_2CO_3. The stronger lines in the first period of burning were found to belong to the neutral atom spectrum. Data are tabulated. (P.C.H.)

39797 ON A KINETIC EQUATION OF A SYSTEM OF CHARGED PARTICLES. N. A. Rud (Lvov State Univ.). Ukr. Fiz. Zh., 8: 645-56(June 1963). (In Ukrainian)

A method is developed for obtaining the kinetic distribution function of a group of s particles. It is shown that the function depends on the correlation kinetic distribution functions of 2, 3, . . . , s particles. An expression is found for any approximation of the function. Equations are derived for correlation kinetic distribution functions, as well as equations for any of their approximations. (auth)

39798 STUDY OF THE CHARACTERISTIC K-ABSORPTION OF X-RAYS AT THE TEMPERATURE OF LIQUID OXYGEN. S. M. Karalnik and V. P. Krivitskii (Kiev State Univ.). Ukr. Fiz. Zh., 8: 690-3(June 1963). (In Ukrainian)

The K-edge absorption of x rays at room temperature and –180°C was studied for a number of elements from vanadium to germanium. Contrary to previous data, no changes were found in the position of K-edge absorption with temperature. (auth)

39799 THERMOEMISSIVE PROPERTIES OF SOME REFRACTORY COMPOUNDS. G. V. Samsonov, V. S. Fomenko, and Yu. B. Paderno (Inst. of Metal Ceramics and Special Alloys, Kiev). Ukr. Fiz. Zh., 8: 700-2(June 1963). (In Ukrainian)

The full current method was used to investigate the thermoemissive properties of TmB_6(+ TmB_4), ScB_2, HfC, NbC, TiN, ZrN, and NbN. A temperature dependence was found for the effective work function for TmB_6(+ TmB_4). An x-ray analysis of the initial nitride and the nitride removed from the core after use showed that phase transformations did not occur at temperatures up to 1800°K and the initial nitride was preserved. (auth)

39800 EMISSION FROM CHARGED PARTICLES PASSING THROUGH THE BOUNDARY OF VACUUM-ANISOTROPIC FERROELECTRICS. V. M. Yakovenko (Inst. of Radiophysics and Electronics, Sverdlovsk, USSR). Ukr. Fiz. Zh., 8: 705-6(June 1963). (In Ukrainian)

Investigations were made of transitory emission at the boundary between a vacuum and gyrotropic anisotropic ferrodielectric with electron motion along the gyrotropic axis (perpendicular to the interface). It was assumed that the mean magnetic penetrability tension is described by $\mu_{ik} = \begin{pmatrix} \mu_1 & i\mu_g & 0 \\ -i\mu_g & \mu_1 & 0 \\ 0 & 0 & \mu_0 \end{pmatrix}$, $\mu_{ik} = \mu^*_{ki}$. Electric properties are considered anisotropic at low frequencies ($\omega \sim 10^{10}$ to 10^{11} sec^{-1}). It was shown that at frequencies where $Re\,\mu_1 < 0$, $Re\,\{\mu_0, \epsilon\} > 0$ i $|\mu_1|^2 \gg |\mu g|^2$, $0 < \mu_0 (\epsilon + [C^2/\nu^2|\mu_1|]) < 1$, Cherenkov emissions from certain waves expand at obtuse angles to particle emissions and a maximum for $n(\omega,\Theta)$ is found in particle flight through the medium. (R.V.J.)

39801 CALCULATIONS OF COLLISION INTEGRALS IN TRANSFER EQUATIONS FOR SHOCK WAVES. T. S. Pidstrigach (Lvov State Univ.). Ukr. Fiz. Zh., 8: 706-7 (June 1963). (In Ukrainian)

Studies were made of shock wave structure in a partially ionized gas. Equations were developed for atom, ion, and electron collisions using Landau kinetic equations in which the collision integral is expressed as $\left(\frac{\partial f}{\partial t}\right)_c = \frac{2\pi L e_1^2 e_2^2}{m^4} \frac{\partial}{\partial v_i} \int \left\{ \frac{f_1}{m_2} \frac{\partial f_2'}{\partial v_k'} - \frac{f_2'}{m_1} \frac{\partial f_1}{\partial V_k} \right\} u_{ik}\, dv'$ (where L is the Coulomb logarithm, $e_{1,2}$ and $m_{1,2}$ are two types of particle charge and mass). (R.V.J.)

39802 MOTION OF ELECTRONS IN MUTUALLY PERPENDICULAR ELECTRIC AND SPACE-MODULATED MAGNETIC FIELDS. V. G. Marinin (Khar'kov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 8: 733-9(July 1963). (In Ukrainian)

A computation and an experimental test were carried out on the motion of electrons in an electric and a space-modulated magnetic field. The resonance interaction of electrons with a space-periodic field is effected with a different ratio among the longitudinal velocity of the electron frequency and period of space-modulation than in the case when there is no radial electric field. This ratio is given for the case when the electric field is set up by a space charge, and the case of a cylindrical condenser. (auth)

39803 NUCLEAR METHODS IN INVESTIGATIONS OF SOLID STATE PHYSICS. S. V. Vonsovskii. Vestn. Akad. Nauk SSSR, 33: No. 8, 55-61(Aug. 1963). (In Russian)

Electron-nuclear methods used in investigations of solid state physics are discussed, and future perspectives and applications are analyzed. (R.V.J.)

39804 THEORETICAL ANALYSIS OF THE RADIAL FIELD VORTEX MAGNETO-GAS DYNAMIC GENERATOR. R. Eleo, W. F. Hughes, et al. Z. Angew. Math. Phys., 13: 1-13(1962).

The magneto-gas-dynamic vortex generator with radial magnetic field was investigated theoretically. Velocity profile, electric characteristics, and efficiency are discussed with regard for the induced currents and fields. (Atomdokumentation, 4: No. 6, Apr. 15, 1962)

39805 INVESTIGATIONS ON ZINC–CADMIUM–SULFIDE PHOSPHORS IN THE TEMPERATURE RANGE FROM 4.2 TO 77.4°K. Peter Thoma (Technische Hochschule, Munich). Z. Angew. Phys., 16: 106-11(Aug. 1963). (In German)

The measurement devices and the methods used for recording the glow curves of phosphors of the ZnS–CdS type at low temperatures are described. Some results of growth and stimulation studies in the spectral range between 0.75 and 1.2 μm and at temperatures between 4.2 and 77.4°K are reported. Some luminescent models and their suitability for the evaluation of the measurement results are discussed. (tr-auth)

39806 ON THE BOUNDARY CONDITIONS AT A SURFACE CONTACT BETWEEN AN IONIZED GAS AND A SOLID. G. A. Lyubimov. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 4, 78-82(July-Aug. 1963). (In Russian)

Approximations were carried out for current distribution in conducting fluid flow in magnetohydrodynamic channels of various design, considering the physical properties of electrode materials. A conducting viscous gas flow at a steady rate in a plane channel with a magnetic field distributed perpendicular to the flow was studied in order to determine the boundary conditions at the gas-solid surface contact. (R.V.J.)

39807 BOUNDARY CONDITIONS FOR DISTRIBUTION FUNCTIONS IN THE CASE OF CHARGED PARTICLES WITH FINITE MOTION. A. N. Dyukalov. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 4, 110-11(July-Aug. 1963). (In Russian)

Kinetic equations were developed for boundary conditions in finite charged particle motion with rare collisions. (R.V.J.)

39808 CONDUCTING FLUID FLOW IN A PLANE CHANNEL. K. E. Dzhugashtin. Zh. Tekhn. Fiz., 33: 954-8(Aug. 1963). (In Russian)

Studies were made of incompressible conducting flow under a gravitational pressure in a plane infinite channel. An accurate solution was found for the non-stationary problem involving an external magnetic field transverse to the channel walls. A solution was also found for stationary flow in crossed magnetic and electric fields. (R.V.J.)

39809 THE THEORY OF SUPERCONDUCTIVITY. N. N. Bogoliubov. International Science Review Series, Volume IV. New York, Gordon and Breach Science Publishers, 1962. 369p. $4.95.

A compilation of papers on the theory of superconductivity that previously appeared in periodical literature is presented. The topics presented include the ground state at absolute zero, interaction of electrons with lattice vibrations, quasi-chemical approach to superconductivity, anomalous skin effect in normal and superconducting metals, periodic systems, thermodynamic functions of supercon-

ductors, the Meissner effect and gauge invariance, coherent excited states, random-phase approximations, diamagnetism of dense electron gas, and the Meissner effect in the quasi-chemical equilibrium theory of superconductivity. (C.E.S.)

39810 ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS. VOLUME 18. L. Marton, ed. Adv. Electron. Electron Phys., 18: 1-342(1963). New York, Academic Press, 1963. $12.50.

Topics including the nightglow, developments in computer organization, atomic collisions involving low energy electrons and ions, semiconductor device evaluation, and electron emission microscopy were presented. Separate abstracts are prepared for the sections on the nightglow and atomic collisions. (C.E.S.)

39811 THE NIGHTGLOW. F. E. Roach (National Bureau of Standards, Boulder, Colo.). Adv. Electron. Electron Phys., 18: 1-44(1963).

Nightglow and the units of brightness are defined. A spectroscopic description of nightglow is given. Instrumentation for nightglow measurements is described and a listing of nightglow observatories is given. Nightglow from the hydroxyl radical and the O_2 molecule is discussed. Statistical distributions of the oxygen 5577- and 6300-lines, the sodium D-line, and the hydrogen lines Hα and Hβ are given. Excitation mechanisms from photochemical reactions, electrons accelerated by an electric field, and trapped electrons are also discussed. (C.E.S.)

39812 ATOMIC COLLISIONS INVOLVING LOW ENERGY ELECTRONS AND IONS. Manfred A. Biondi (Westinghouse Electric Corp., Pittsburgh). Adv. Electron. Electron Phys., 18: 67-165(1963).

Collisions of electrons and ions with atoms or molecules and with each other in the range from thermal energies to a few ev are discussed. Low energy elastic and inelastic scattering of electrons involving excitation of molecular rotation and vibration states is considered. The attachment of electrons to atoms or molecules and detachment processes are described. A summary of recent advances in the understanding of electron-ion and negative ion-positive ion recombination is presented. (C.E.S.)

39813 ELECTRIC AND ELECTROMAGNETIC SHOCK TUBES. John A. Thornton (Litton Systems, Inc., Beverly Hills, Calif.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-368, 31p, $1.00. (CONF-226-13)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

The classical diaphragm shock tube suffers serious limitations in the production of very high temperatures and velocities. Accordingly electric and electromagnetic shock tubes have received considerable attention as devices capable of generating shock waves both of extremely high Mach numbers, up to several hundred, and of extremely high temperatures, over one hundred thousand degrees Kelvin. Recent investigations have indicated several characteristics, such as electron driven shocks, precursor effects, and driver-driven gas mixing, which affect the applicability of these shock tubes as research tools. These investigations are surveyed and consideration is given to the potentialities, limitations, and design trends which they suggest for electric and EM shock tubes as laboratory devices. Important diagnostic techniques are surveyed. (auth)

39814 A NOTE ON VAPOR-PRESSURE EQUATIONS FOR WATER. Oscar C. Bridgeman and Elizabeth W. Aldrich (Phillips Petroleum Co., Bartlesville, Okla.). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-HT-33, 8p, $1.00. (CONF-129-14)

From American Society of Mechanical Engineers, American Institute of Chemical Engineers 6th National Heat Transfer Conference and Exhibit, Boston, Aug. 1963.

The approximation polynomial approach to data correlation is discussed, and an approximation polynomial equation was developed for the vapor pressure of water over the entire liquid range. (P.C.H.)

Astrophysics, Cosmology, and Geophysics

39815 THE INTERSTELLAR ABUNDANCE OF THE HYDROGEN MOLECULE. I. BASIC PROCESSES. Robert J. Gould and Edwin E. Salpeter (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 138: 393-407(Aug. 15, 1963).

At present, interstellar molecular hydrogen is incapable of detection, although a high abundance has been suspected for almost two decades. An analysis is given of the various processes which determine the molecular concentration in H I clouds. The most important mechanism for forming molecular hydrogen is association on the surface of the interstellar grains, the characteristic time for conversion to molecular form being about 10^8 years. It is shown that the range of grain temperatures where this recombination reaction is efficient is coincident with the range 5 to 20°K, which is expected to result from the interaction with the interstellar radiation field. It is estimated that the efficiency (recombination coefficient) of the process is between 0.1 and 1. Regarding dissociative processes, photodissociation through the forbidden transition between the two Heitler-London states of the molecule, previously thought to be most important, is shown to be negligible. Ionization and dissociation of a cloud by random encounters with O and B stars occur about once every 10^8 years, so that if the grain recombination process is operative, a balance results in which the molecular abundance is roughly comparable with the observed atomic concentration. The cooling properties of molecular hydrogen are discussed. (auth)

39816 THE INTERSTELLAR ABUNDANCE OF THE HYDROGEN MOLECULE. II. GALACTIC ABUNDANCE AND DISTRIBUTION. R. J. Gould, T. Gold, and E. E. Salpeter (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 138: 408-25(Aug. 15, 1963).

Observations of the distribution in space and velocity of gas clouds, together with considerations of dynamical astronomy, suggest that the total mass density near the galactic plane is appreciably higher than the observed density of visible stars and atomic hydrogen gas. The distribution of K giant stars is compatible also with a high density of invisible mass, and it is suggested here that this is contributed by molecular hydrogen gas. Radii of Strömgren spheres for O and B stars are evaluated, and the average rates of dissociation and ionization of molecular hydrogen, due to random encounters of gas clouds with bright stars, are calculated. Using the rates for the association of hydrogen molecules on the surfaces of dust grains, calculated previously, the mean equilibrium abundance ratio of molecular to atomic hydrogen is calculated. This ratio is found to be almost independent of the height above the galactic plane and to lie in the range 0.1 to 10. The effect of molecular hydrogen on the harmonic mean temperature of gas clouds is discussed. (auth)

39817 THE FORMATION OF H II REGIONS. [PART] II. Peter O. Vandervoort (Yerkes Observatory, Williams Bay, Wis.). Astrophys. J., 138: 426-36(Aug. 15, 1963).

The problem of the formation of an H II region, which was formulated in an earlier paper, is investigated by means of the method of characteristics. The characteristic equations governing the motion of the ionized gas are solved by an iterative method based on the circumstance that intervals of time in the problem are small compared with the interval of time required for a sound wave to cross the H II region. (auth)

39818 EXCLUSION PRINCIPLE INHIBITION OF BETA DECAY IN STELLAR INTERIORS. Vern L. Peterson and John N. Bahcall (Indiana Univ., Bloomington). Astrophys. J., 138: 437-51(Aug. 15, 1963).

Beta decay in a high-density electron gas is investigated. It is shown that the exclusion principle can play an important role in determining the decay rate. Tables describing allowed, first-forbidden nonunique, and first-forbidden unique decays are presented; these tables give the dependence of the beta-decay rate on the local temperature, electron density, and beta-decay energy. If the Fermi energy of the free electrons exceeds the beta-decay energy, the decay rate is strongly inhibited; the amount of inhibition decreases with increasing temperature. The relativistic dependence of the degeneracy parameter on temperature and electron density is also tabulated. (auth)

39819 MODES OF MASS EJECTION BY BINARY STARS AND THE EFFECT OF THEIR ORBITAL PERIODS. Sh-Shu Huang (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 138: 471-80(Aug. 15, 1963).

Three modes of mass ejection from one or both components of a binary system were idealized and their physical characteristics discussed, in order to predict their effect on the orbital period of the system. Also, the consequence of synchronization of axial rotation of component stars with their orbital revolution is examined. (auth)

39820 TRANSFER OF ANGULAR MOMENTUM BETWEEN EJECTED PARTICLES AND THE BINARY SYSTEM. Su-Shu Huang (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 138: 481-6(Aug. 15, 1963).

Transfer of angular momentum between the ejected particle and the binary system itself was studied numerically in the framework of the restricted three-body problem and the general behavior of such transfer for particles of high velocities of ejection is elucidated. Tables are given for the angular momentum that will be carried away to infinity under various initial conditions of ejection. (auth)

39821 ON SECOND HELIUM IONIZATION AS A CAUSE OF PULSATIONAL INSTABILITY IN STARS. John P. Cox (Joint Inst. for Lab. Astrophys., Boulder, Colo.). Astrophys. J., 138: 487-536(Aug. 15, 1963).

This investigation was to test the hypothesis that He^+ ionization in the envelope is the source of the instability in cepheid variables and possibly also in other types of pulsating stars. Numerical solutions of the complete set of linearized, nonadiabatic pulsation equations were obtained for a large number of simplified stellar envelope models in radiative equilibrium. The solutions were used to compute the (negative) dissipation in the envelopes and to estimate the (positive) dissipation in the interiors. The parameter values were chosen so that the envelopes correspond approximately to classical cepheids, RR Lyrae variables, W Virginis variables, and zero-age main-sequence stars in the middle and late A's. (auth)

39822 KINEMATICAL HYDROMAGNETIC THEORY AND ITS APPLICATION TO THE LOW SOLAR PHOTOSPHERE. E. N. Parker (Univ. of Chicago). Astrophys. J., 138: 552-75(Aug. 15, 1963).

The magnetic field B is computed from the hydromagnetic equations for a variety of given velocity fields v. The velocity fields are classified as turbulent if their time correlation extends no more than their scale a divided by their characteristic velocity v. The velocity fields are classified as persistent if their time correlation extends beyond a/v but is short compared with the magnetic diffusion time a^2/λ ($\lambda \equiv c^2/4\pi\sigma$), and as stationary if their time correlation extends beyond a^2/λ. It is shown that turbulent fluid motions in the solar photosphere generate r.m.s. fields which are a few times the large-scale field strength B_0 in the photosphere. Where $B_0 \gtrsim 20$ gauss, this leads to equipartition of energy between the turbulent magnetic and velocity fields. It is conjectured that, since plages occupy the areas on the solar surface where $B_0 \gtrsim 20$ gauss, there may be some connection between equipartition and plage formation. It is shown that persistent motions tend to draw the field into concentrated sheets and filaments. The observed supergranulation in the solar atmosphere tends to concentrate vertical magnetic fields around the edges of the cells, where the field density may become 10^2 times larger than in the interior of the cell. It is shown that stationary motions tend to exclude the magnetic field from the region of fluid motion. A number of examples are given to show the distortion of the field by the forces exerted by the fluid diffusing through it. It is to be hoped that observations will yield simultaneous velocity and magnetic-field maps so that quantitative comparison can be made with the expected theoretical results. (auth)

39823 SURVEY OF THE POLARIZATION OF JOVIAN RADIATION AT DECAMETER WAVELENGTHS. W. M. Sherrill and M. P. Castles (Southwest Research Inst., San Antonio, Tex.). Astrophys. J., 138: 587-98(Aug. 15, 1963).

The polarization characteristics of the decameter nonthermal emission from the planet Jupiter were observed at Southwest Research Institute during the 1962 apparition. Polarization was observed at 24.2, 22.2, 20.2, 19.2, 18.2, 17.2, 16.2, and 15.2 Mc. The polarization survey showed a significant trend toward left-hand and mixed polarized radiation at frequencies below 20 Mc. The seven mixed polarized occurrences observed show two types of mixed events. One type showed systematic change from left- to right-hand sense at a given frequency over periods of an hour. The other type showed maximum rate of change of polarization sense of the order of four times per minute at a given frequency. Right-hand and left-hand bursts were observed which could be associated with each of the three principal sources near System III (1957.0) longitudes of 110°, 230°, and 320°. The axial ratios averaged for each source showed AR $\simeq \pm 1.2$ for the 230° source, with more elliptical axial ratios of the order of ± 2 for the sources at 110° and 320°. (auth)

39824 THE STABILITY OF IONIZATION FRONTS AND THE EVOLUTION OF H II REGIONS. Peter O. Vandervoort (Yerkes Observatory, Williams Bay, Wis.). Astrophys. J., 138: 599-601(Aug. 15, 1963).

An ionization front is considered that forms the boundary of a spherically symmetric H II region. The stability of such fronts is discussed in regard to the evolution of the H II regions. (R.E.U.)

39825 APPROXIMATE EVALUATION OF THE FERMI-DIRAC FUNCTIONS. Claude Arpigny (Carnegie Institution of Washington, D. C. and California Inst. of Tech., Pasadena). Astrophys. J., 138: 607-9(Aug. 15, 1963).

The Fermi-Dirac functions are required in the computation of stellar configurations involving partially degenerate matter. The coefficients of these functions are given in tabular form. (R.E.U.)

39826 ON THE STATISTICAL RELATIONS BETWEEN FLARE INTENSITY AND SUNSPOTS. G. R. Greatrix. Monthly Notices Roy. Astron. Soc., 126: 123-33(1963).

A statistical analysis of data relating to nearly 4,000 solar flares for the periods January 1, 1947, to May 1, 1949, and January 1, 1956, to January 1, 1957, yielded the following principal results: (a) The intensity of a solar flare is dependent on the geometry of the associated sunspot magnetic field. The more complex the geometry, the greater the probability of an intense flare occurring. The intensity is independent of the rate of change in the area of the spot group; (b) The frequency of solar flares occurring in a given interval of time and associated with a given spot group is a linear function of the area of the spot group, and of the rate of change in that area. It is shown that, for the purpose of this work, the area of a spot group can be used as an approximate measure of the magnetic flux passing through that group. Thus, the relations between solar flares and spot area can be regarded as being the relations between solar flares and magnetic flux. (auth)

39827 THE PATTERN OF MAGNETIC FIELDS IN SUNSPOTS: AN OBSERVATIONAL DETERMINATION. M. G. Adam (Oxford Univ.). Monthly Notices Roy. Astron. Soc., 126: 135-53(1963).

The configuration of the lines of force, along a central section of a single, regular sunspot, is determined for three disk positions of the spot. To obtain the heliographic directions of the magnetic field it is necessary to measure position angles for the lines of force, as well as their inclination to the sight-line. This is done by a full analysis of the state of polarization of the Zeeman components of the Fe lines 6302.5 and 6265.1, in sunspot spectra obtained with the Oxford 35m telescope and 11m spectroscope. The analysis is made by the measurement of Babinet fringes according to the method introduced by Treanor. Telescope polarization is measured and effectively eliminated by combining the results for the red and violet σ-components of the Zeeman pattern. An ambiguity, inherent in the determination of position angles by polarization methods is pointed out; this is resolved by general considerations, but future observations should be planned to remove this uncertainty. The magnetic field directions across the spot section show only a very limited range of inclinations to the solar radius, and do not lie in the normal plane of the central section. The directions change from day to day quite markedly, although the magnetic field strength pattern is found to be quite stable. The observed field directions do not follow the commonly accepted directions of the Evershed flow of material. (auth)

39828 MICROMETER AND PHOTOMETRIC OBSERVATIONS OF A SUNSPOT VELOCITY FIELD. F. Holmes (Oxford Univ.). Monthly Notices Roy. Astron. Soc., 126: 155-64(1963).

High dispersion spectra (0.2 Å/mm) were taken during the passage of one sunspot across the solar disk, for simultaneous micrometer and photometric investigations of a sunspot velocity field. The Fe I line at 5576 Å was selected for the investigation because it is unaffected by the sunspot magnetic field (Lande splitting factor g = 0). From detailed micrometer measurements solutions were attempted for umbral and penumbral velocity components. The photometric analysis is based on a determination of the line contour 5576 Å across the sunspot for three disk positions. An attempt is made to relate the penumbral line asymmetry (line-flare) with visual measures of the line shift. The micrometer measurements show that the umbral motion is characterized by a small vertical velocity of descent (0.1 km/sec), while the predominantly radial, penumbral velocity field pattern appears to be both flattened and broadened during the passage of the spot from center to limb. From the photometric measurements it is found that the line ssymmetry is greatest at approximately the position of the maximum sight-line velocity within the spot, and appears more pronounced for spot positions nearer the solar limb. It is clear that in visual sunspot measures the eye does not set on the line-core but at a point towards the penumbral line-flare. The equivalent width of 5576 Å shows a marked increase from the photosphere to sunspot. The central intensity of the line within the spot increases with distance from the spot center. (auth)

39829 NEWTONIAN UNIVERSES WITH SHEAR AND ROTATION. F. V. Narlikar (King's Coll., Cambridge, Eng.). Monthly Notices Roy. Astron. Soc., 126: 203-8 (1963).

Cosmological models involving shear and rotation are considered within the framework of Newtonian theory. It is shown that, under certain assumptions, a differential equation can be obtained for the volume expansion factor. The solutions of this equation show that it is not possible to get nonsingular finitely oscillating cosmological models. (auth)

39830 RIOMETER OBSERVATIONS OF IONOSPHERIC ABSORPTION DUE TO THE SOLAR FLARES OF APRIL 15, 1963. S. Horowitz (Air Force Cambridge Research Labs., Bedford, Mass.) and S. C. Goldman. Nature, 199: 1147-9 (Sept. 21, 1963).

A riometer network, installed at various locations around the world, yielded absorption data on two Type II solar flares that occurred on April 15, 1963, beginning at 1123 and 1614 U.T., respectively. The first flare was accompanied by a severe noise storm that began about 10 min after the conclusion of the first major period of absorption. All the riometers located on the sunlit side of the Earth observed the flares and absorption data obtained are given. A riometer located near the south geomagnetic pole indicated no electromagnetic effects and strong absorption effects due to incoming charged particles. (P.C.H.)

39831 NEUTRAL HYDROGEN IN THE VIRGO CLUSTER. B. J. Robinson, K. J. Van Damme, and J. A. Koehler (CSIRO, Sydney). Nature, 199: 1176-7(Sept. 21, 1963).

Neutral hydrogen was detected in absorption in the Virgo cluster of galaxies by measurements of the spectrum of the radio source Virgo A (M87). Observations were made using a 210 ft radio telescope and a parametric frequency-switching receiver. The measurements on Virgo A show absorption amounting to 0.65 K in antenna temperature at a red shift of 1100 km/s, close to the recession velocity of M87. The measurements also show that the velocity dispersion of the gas is less than the velocity dispersion of the member galaxies of the Virgo cluster, ±550 km/s. It was concluded that whatever the distribution of the neu-

tral hydrogen its total mass appears to be insufficient to affect the dynamical instability of the cluster suggested by application of the virial theorem to its brighter member galaxies. (P.C.H.)

39832 RADIATION FROM JUPITER AT 178 Mc/s. J. F. R. Gower (Cambridge Univ., Eng.). Nature, 199: 1273(Sept. 28, 1963).

Observations were made of the decimeter radio emission from Jupiter at a frequency of 178 Mc over the period June 22 to July 1, 1963, using both a fan-beam system and an interferometer. A procedure was developed in which the records obtained on one day are subtracted from those taken on another day when the position of Jupiter has altered by more than the beam width of the instrument. The mean values derived for flux density were $3.3 \pm 0.45 \times 10^{-26}$ w m^{-2} $(cps)^{-1}$ for the fan beam and $3.8 \pm 0.4 \times 10^{-26}$ w m^{-2} $(cps)^{-1}$ for the interferometer. It was concluded that, over the period of observation, the flux density of Jupiter did not vary by more than 20%. (M.C.G.)

39833 THE PROPAGATION OF SHOCK WAVES IN THE INSIDE OF STARS. [PART] II. A. Masani (Centro di Astrofisica del C.N.R., Milan). Nuovo Cimento (10), 29: 224-46(July 1, 1963). (In English)

The equation of propagation of a shock wave in its form fitting to applications to a generic medium with spherical symmetry is given and is applied to a series of models. It is shown that the central zones of stars are stable for propagation of shock waves while the outer ones are unstable and that near the separation surface between the nucleus and the envelope there is stability or instability according to the model. The minimum value of amplitude ($z = P_1/P_2$) for which one can still speak of shock wave is discussed. It has been established that this value is around 2 to 3. Results are discussed making reference to observational data. (auth)

39834 PHOTONEUTRINO EMISSION AND NEUTRON PRODUCTION IN THE $\gamma + p \rightarrow n + \nu + e^+$ PROCESS IN STARS. D. Boccaletti, V. de Sabbata, and C. Gualdi (Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cimento (10), 29: 275-80(July 1, 1963). (In English)

The reaction $\gamma + p \rightarrow n + \nu + e^+$ and its implications in stellar evolution are considered. The neutrino emission and neutron production seem to have some importance in the superdense stars. (auth)

39835 SYNTHESIS OF Fe-GROUP ELEMENTS BY THE RAPID NUCLEAR PROCESS. Hiroshi Tsuda and Hiroyuki Tsuji (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 30: 34-44(July 1963). (In English)

The rates of (p,γ), (γ,p), (α,γ), (γ,α), and (p,α) reactions at temperature $(0.5 \sim 2.0) \times 10^{9}$°K are calculated for nuclei in the range $A = 40 \sim 60$ and it is shown that the α-particle reactions can be neglected for temperature below 2×10^{9}°K unless the number ratio of α particles to protons is larger than 10^7. Using the above results, it is shown that Fe-group elements are synthesized by the proton capturing process under the stellar conditions of supernova explosion. As the results of calculation, it is found that the observed relative abundances of Fe-group elements lighter than A = 56 may be explained as the final results of the proton capturing process at temperature $(1.0 \sim 1.2) \times 10^{9}$°K in proton density 1 g cm^{-3} during the time of $(7 \sim 30) \times 10^2$ sec or at temperature $(1.0 \sim 1.5) \times 10^{9}$°K in proton density 10 g cm^{-3} during the time of $(2 \sim 40) \times 10$ sec. (auth)

39836 ULTRA-HIGH ENERGY γ-RAYS FROM INTERGALACTIC SPACE. Satio Hayakawa and Yoshiaki Yamamoto (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 30: 71-83(July 1963). (In English)

The intensity and the energy-spectrum of high-energy γ rays arising from the collisions of cosmic protons and thermal photons in the intergalactic space are calculated. The calculation gives the result that the ratio of the frequency of extensive air showers initiated by γ rays to that of cosmic particles is 2×10^{-4} for shower sizes greater than 10^6 at mountain altitude and about 10^{-3} at sea level. This calculated value is rather small in this size range, but increases with shower size. For example, it reaches a maximum value, about 5×10^{-3} at mountain altitude and about 10^{-2} at sea level for shower sizes greater than 10^7. It is emphasized that the result should be examined by observations of extensive air showers of shower size greater than 10^7, and also that the observations of γ-ray initiated air showers provide useful means of investigating high energy interactions and cosmology. (auth)

Cosmic Radiation

39837 COMPOSITION AND ENERGY SPECTRA OF THE HEAVY PRIMARY COSMIC RADIATION. F. Foster and A. Debenedetti (Oxford Univ.). Nuovo Cimento (10), 28: 1190-9(June 16, 1963). (In English)

Results of investigations into the cosmic-ray heavy primary charge and energy spectra at Neepawa, Canada (geomagnetic latitude 61°N), during a time of high solar activity (August 1958) are presented. The total heavy-primary differential energy spectrum is shown to have the same shape as the contemporaneous α-particle spectrum, but the L/M ratio shows an increase from (0.28 ± 0.05) at kinetic energies over 1.5 Bev/nucleon to (0.43 ± 0.07) at energies less than 1.0 Bev/nucleon. (auth)

39838 NUCLEAR INTERACTIONS OF THE SECONDARY PARTICLES OF HIGH-ENERGY COSMIC-RAY "JETS." E. Farrow, C. F. Gauld, C. B. A. McCusker, J. Malos, K. Nishikawa, L. S. Peak, and L. G. Van Loon (Univ. of Sydney). Nuovo Cimento (10), 28: 1238-45 (June 16, 1963). (In English)

Fifty-five interactions in the energy range 1 to 100 Bev of secondary particles of cosmic-ray jets were examined. The energy was determined by finding the angle between the secondary and primary direction and assuming a transverse momentum of 0.4 Bev/c. The interaction mean free path was 41.7 cm, the average number of shower particles varied from 1.3 to 6.4, and the average number of black prongs from 5.8 to 8.3 as the energy went from 2.8 to 34.6 Bev. The agreement with machine work is good, in contrast to previous experiments where the Castagnoli method of energy estimation and/or area scanning was used. The application of the method to energies around 1000 Bev is discussed. (auth)

39839 $\bar{K}$-N SCATTERING IN THE MANDELSTAM REPRESENTATION. II. REGGE TRAJECTORY OF K^* MESON. S. Iwao (Università, Genoa and Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo Cimento (10), 28: 1246-57(June 16, 1963). (In English)

A method of reggeizing the amplitude is applied to the interaction $K^- + p \rightarrow \Sigma^+ + \pi^-$. A slight modification is made in order to discuss the presently available data, where the square of the baryon mass cannot be neglected compared to the total energy squared. The data are rather poor to determine the theoretical parameters precisely, but the general trend obtained is consistent with the assumption that the $J = 1$ K^* meson is the top trajectory with

the strangeness 1. A method of polology in the angular momentum space is discussed. Assuming the existence of K^* with $I = 3/2$, the nature of that resonance is predicted from the $K^- + p \rightarrow \Sigma^* + \pi^+$ data. (auth)

39840 MEASUREMENT OF THE COSMIC-RAY NEUTRON FLUX IN THE ATMOSPHERE. G. Boella, G. Degli Antoni, C. Dilworth, G. Giannelli, E. Rocca, L. Scarsi, and D. Shapiro (Università, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cimento (10), 29: 103-17 (July 1, 1963). (In English)

A neutron detector, employing boron-plastic scintillator counters and designed for the measurement of low neutron fluxes, is described. The performance of this instrument in the measurement of cosmic-ray neutron flux both at sea level and in balloon flights is discussed. Preliminary data on the absolute flux of cosmic-ray neutrons in the atmosphere and the variation of the flux with atmospheric depth are given and compared to previous and predicted values. (auth)

Criticality Studies

39841 (BNL-6758) THEORETICAL ANALYSIS OF THE EXPONENTIAL EXPERIMENT IN NATURAL URANIUM. Paul Michael (Brookhaven National Lab., Upton, N. Y.). Feb. 1963. Contract AT-30-2-GEN-16. 31p.

Methods of calculating the "Snell Experiment" (the exponential experiment in natural uranium) are examined. It is found that integral transport theory is required for accurate predictions. The effect of spatial transients upon measured quantities is studied and it is found that experiments have not been done in a large enough mass of uranium to achieve an asymptotic neutron distribution. However, deviations from the asymptotic values of integral quantities are not large and corrections are calculated and applied to recent experiments. It is shown that the use of recent cross section data improves the agreement between theory and experiment. The relaxation length and all spectral indices are in fairly good agreement except for Np^{237} to U^{238} average fission cross section ratio. (auth)

39842 (ORNL-TM-686) LIMITING CRITICAL CONCENTRATIONS OF AQUEOUS NITRATE SOLUTIONS OF FISSILE AND FERTILE ISOTOPES. J. P. Nichols (Oak Ridge National Lab., Tenn.). Sept. 27, 1963. Contract [W-7405-eng-26]. 6p.

The results of IBM-7090 MODRIC calculations of the limiting critical concentrations of aqueous nitrate solutions of $U^{235}-U^{238}$, $U^{235}-Th^{232}$, $U^{233}-Th^{232}$, $Pu^{239}-U^{238}$, and $Pu^{239}-Th^{232}$ are presented. (auth)

39843 THE MARIUS EXPERIMENTAL ASSEMBLY. F. Cogne. Energie Nucl., 5: 318-21(June 1963). (In French)

The Marius critical assembly is used for the study of the physics of natural U–graphite systems, using substitution and oscillation methods. The lattice pitches, channel diameter, and fuel elements of the central zone can be modified. The assembly was used to determine the characteristics of the EDF-1 and to orient the study of succeeding projects. (J.S.R.)

Elementary Particles and Radiations

Refer also to abstracts 38608, 38623, and 39447.

39844 (BNL-7258) TOTAL CROSS SECTIONS FOR K MESONS AND π MESONS ON PROTONS AND DEUTERONS BETWEEN 2.5 AND 6 Bev/c. W. F. Baker, E. W. Jenkins, T. F. Kycia, R. H. Phillips, A. L. Read, K. F. Riley, and H. Ruderman (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 16p. (CONF-216-1)

From International Conference on Elementary Particles, Sienna, Italy, Sept.-Oct. 1963.

Experimental results show that very little, if any, structure occurs in the total cross section for either isotopic spin state of the π-N system, and no evidence for such structure in the K^+-N total cross sections was observed. Charge symmetry predictions for the π-d total cross sections appear to be valid to $\frac{1}{3}\%$ or better. The data are also consistent with the Glauber theory of N-N shielding in the deuteron. The K^+-p and K^+-n total cross sections appear to vary smoothly, and no evidence for anything other than a smooth fall off of $\sigma(K^-$-p) between 1.2 and 6 Bev/c is noted. (D.C.W.)

39845 (NP-13114) ANALYSIS OF THE ANGULAR DISTRIBUTION OF PION-NUCLEON SCATTERING WITHIN THE FRAMEWORK OF THE MANDELSTAM REPRESENTATION. Technical Report No. 44. Gordon L. Kane (Illinois. Univ., Urbana). July 1963. Contract ONR-1834(05). 79p.

A method is presented for analyzing pion-nucleon scattering data using phase shifts for the low partial waves and a closed term to represent the effect of all higher partial waves. The modification of the conventional phase shift analysis consists of writing the scattering amplitude as a sum of two terms. The method is used in an analysis of π^+-p data. (auth)

39846 (UCRL-2426(Vol.III)(1963 Ed.)) HIGH-ENERGY PARTICLE DATA. VOLUME III. KINEMATICS OF PARTICLES AS A FUNCTION OF MOMENTUM. W. Peter Trower (California. Univ., Berkeley. Lawrence Radiation Lab.). July 1, 1963. Contract W-7405-eng-48. 114p.

Kinematic quantities are plotted as a function of particle momentum for the most common elementary particles. Dynamic quantities as a function of incident-particle momentum are plotted for interactions of most of these particles with a proton. Some techniques of relativistic kinematics are also included. (D.C.W.)

39847 (UCRL-11018) SIGN OF THE $K_1^0-K_2^0$ MASS DIFFERENCE. Gerald W. Meisner, Robert L. Golden, Bevalyn B. Crawford, and Frank S. Crawford, Jr. (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 16, 1963. Contract W-7405-eng-48. 9p. (CONF-231-1)

From International Conference on Fundamental Aspects of Weak Interactions, Upton, N. Y., Sept. 1963.

An examination of the phase shifts of K^0 and $\overline{K}^0$ parts of K^0 (a superposition of K^0 and $\overline{K}^0$) in $\pi^- - p \rightarrow \Lambda + K^0$ due to the processes $K^0 - p \rightarrow K^0 + p$ and $\overline{K}^0 - p \rightarrow \overline{K}^0 + p$, respectively, indicates that the mass of $K_2^0 >$ that of K_1^0 and that $|m_1 - m_2|$ is about 1.6 natural units. (D.C.W.)

39848 (AEC-tr-6059) CALCULATION OF DISTRIBUTION FUNCTION MOMENTS OF CASCADE PARTICLES. S. Z. Belenkii (Belenky). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Zh. Eksperim. i Teor. Fiz., 19: 940-5(1949). 8p.

A recurrent formula that permits calculation of all distribution function moments of cascade particles in series is derived. The distribution function is calculated by the moment method for some extreme cases. (auth)

39849 DEPOLARIZATION OF ARBITRARILY POLARIZED ELECTRONS AND POSITRONS IN MØLLER AND

BHABHA SCATTERING. Teuvo Kohonen (Inst. of Tech., Helsinkii). Ann. Acad. Sci. Fennicae, Ser. A VI, No. 117, 1-42(1963). (In English)

The theoretical expressions for the depolarization of arbitrarily polarized electrons, and positrons in Møller and Bhabha scattering are derived. Some typical angular cases are calculated numerically with the aid of an electronic computer and plotted. Two important approximations are derived for the nonrelativistic case and the small-angle scattering case. (auth)

39850 A MODEL OF BARYON STATES. R. E. Cutkosky (Carnegie Inst. of Tech., Pittsburgh). Ann. Phys. (N. Y.), 23: 415-38(Sept. 1963).

The self-consistent bound-state approach is applied to the meson and baryon octet model. An estimate is made of the mass differences within the baryon multiplet. Predictions of the model for the properties of the $P_{\frac{1}{2}}$, $D_{\frac{1}{2}}$, and more highly excited states are examined. (R.E.U.)

39851 ON THE ABSORPTION OF THE β-PARTICLES IN ALUMINIUM. L. Daddi and V. D'Angelo (CAMEN, Pisa, Italy). Intern. J. Appl. Radiation Isotopes, 14: 341-6 (Aug. 1963). (In English)

The limits of validity of exponential and binomial functions in the mathematical representation of the absorption of the β particles in Al were examined. The results show that the actual absorption law is to be considered exponential up to transmissions of about 15%. In absolute β counting it is possible to extrapolate to zero thickness by an exponential function when the absorbers are put close to the thin window of the detector. For the identification of β emitters by the absorption coefficient it is possible to make use of the μ value in the initial part of the curves. (P.C.H.)

39852 ON THE DIFFUSE REFLECTION OF PARALLEL RAYS BY AN INHOMOGENEOUS FLAT LAYER AS A LIMITING PROCESS. Richard Bellman, Robert Kalaba, and Sueo Ueno (RAND Corp., Santa Monica, Calif.). J. Math. Anal. and Appl., 7: 91-9(Aug. 1963).

The diffuse reflection of parallel rays by an inhomogeneous, plane-parallel, nonemitting, and isotropically scattering atmosphere of finite optical thickness is developed. The S-function for the standard diffuse reflection problem is derived. The standard diffuse reflection problem is considered as a limiting process of a collimated point source problem and as a limiting process of a transient diffuse reflection problem when the incident intensity is given in the form of the unit step function of time. (C.E.S.)

39853 ANGULAR DISTRIBUTION OF PROTONS FROM THE d(d,p) REACTION. Y. K. Tai and Y. C. Hsu (National Taiwan Univ., Taipei, Taiwan, China). Nucl. Phys., 46: 153-60(July 1963). (In English)

The angular distributions of protons from the d(d,p) reaction were observed from 120 to 200 kev incident deuteron energy by use of a thin gas target. For the detection of the protons, Kodak NTB nuclear plates of thickness 100 μm were used. Some details of experimental equipment and procedures are described. The angular distribution observed can be represented in the c.m. co-ordinate system by the expression $(1 + A\cos^2\theta)$, for which the values of A are given. (auth)

39854 PHYSICAL INTERPRETATION OF THE UNPHYSICAL REGION. Y. S. Jin (Technische Hochschule, Karlsruhe, Ger.). Nucl. Phys., 46: 193-202(July 1963). (In English)

A rigorous procedure for a physical interpretation of the unphysical region, which persists for zero momentum-transfer and is due to pure two-particle intermediate states, is presented. To effect the analytic continuation to the unphysical region, the analyticity of the reaction matrix is applied, which follows from analyticity of the partial-wave amplitudes and unitarity. (auth)

39855 THE Z-DEPENDENCE OF SINGLE QUANTUM ANNIHILATION OF POSITRONS. H. Weigmann, H. Hansen, and A. Flammersfeld (Universität, Göttingen, Ger.). Nucl. Phys., 45: 555-60(Aug. 1963). (In German)

The Z-dependence of single-quantum annihilation of positrons was studied with the aid of a β-ray spectrometer and a counter-telescope. Monoenergetic γ-quanta due to single-quantum annihilation in thin foils of elements in the range from Z = 50 to Z = 92 were observed at two different values of the positron kinetic energy. According to these measurements at positron kinetic energies of 760 kev and 1100 kev the exponent of Z in the total cross section of single-quantum annihilation is $\nu = 3.2 \pm 0.6$ and $\nu = 3.8 \pm 0.8$, respectively, which does not agree with the value predicted by the Born-approximation $\nu(\text{Born}) = 5$. (auth)

39856 EXACT EQUIVALENCE OF THREE SCALAR THEORIES OF THREE SCALAR PARTICLES. E. G. P. Rowe (Imperial Coll. of Science and Tech., London). Nucl. Phys., 45: 593-601(Aug. 1963). (In English)

It is shown that three theories, in which different combinations of a charged particle, a neutral particle, and a doubly-charged particle are taken as elementary, are exactly equivalent. (auth)

39857 DISPERSION RELATIONS FOR PHOTOPRODUCTION OF K-MESONS ON NUCLEONS AND π-MESONS ON HYPERONS. N. F. Nelipa and V. A. Tsarev (Lebedev Inst. of Physics, Moscow). Nucl. Phys., 45: 665-78(Aug. 1963). (In English)

Integral equations are obtained for the partial amplitudes of the photoproduction of K mesons on nucleons and the associated process of photoproduction of pions on hyperons. Cases of identical and different relative parities of the initial fermion and the final fermion-meson system are considered. (auth)

39858 ELECTRON-ELECTRON SCATTERING CROSS-SECTION TAKING INTO ACCOUNT HARD-PHOTON RADIATION. V. N. Bayer and S. A. Kheifets (Novosibirsk State Univ., USSR). Nucl. Phys., 47: 313-27(Aug. 1963). (In English)

Radiation corrections for the electron-electron scattering cross section are calculated, taking into account hard photon radiation, by a numerical integration of the precise formula for bremsstrahlung in an electron-electron collision. The corrections are found to be 15.8% and 10.6% for a scattering angle of 40°, and 19.6% and 14.4% for that of 90° for electrons with energies of 100 and 500 Mev in the c.m.s., respectively. Analytical expressions are obtained for the asymptotic behavior of hard-photon contribution in the limit of rather hard photons and relatively soft photons. (auth)

39859 DEUTERON DISINTEGRATION IN d-p SCATTERING AT 24.35 Mev. W. T. H. Van Oers and K. W. Brockman, Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., 47: 338-52(Aug. 1963). (In English)

Energy spectra of protons from the reaction $d + p \rightarrow p + p + n$ with $E_d = 24.35$ Mev were measured as function of angle. The angular region for observing protons is limited by kinematics to angles smaller than 58°. After conversion to the center-of-mass system the shapes of the energy

spectra show similar behavior in comparison with the spectra obtained in measurements at other energies. The estimated total cross section for emission of protons in the forward hemisphere, which is equivalent to the backward hemisphere when protons are impinging with half the energy, is 230 mb. (auth)

39860 ENERGY DETERMINATION FROM THE ANGULAR DISTRIBUTION OF THE SECONDARY SHOWER PARTICLES. H. H. Aly, C. M. Fisher, and A. Mason (Univ. of Bristol, Eng.). Nuovo Cimento (10), 28: 1117-26 (June 16, 1963). (In English)

Nuclear interactions induced by 4.5-Bev π^- mesons, 6-Bev protons, and 17-Bev π^- mesons in emulsions were analyzed to test at these energies the methods of energy determination used with high-energy cosmic-ray interactions. Variation of the estimated energy with n_s the number of shower particles and N_h the number of evaporation prongs was investigated. (auth)

39861 THE EFFECT OF HARD-CORE AND THREE-BODY FORCES IN THE Λ-NUCLEON INTERACTION. L. F. Abou-Hadid (University Coll., London). Nuovo Cimento (10), 28: 1169-76(June 16, 1963). (In English)

An improved trial function with four parameters is used to calculate, by a variational method, the well-depth parameter S_Λ of the Λ-nucleon interaction in ${}_\Lambda H^3$. The effect of the presence of the hard core on this parameter as well as the effect of the three-body forces is investigated. (auth)

39862 A PULSED MAGNETIC STUDY OF THE PROPERTIES OF SURVIVING BARYONS IN 25 Gev/c PROTON INTERACTIONS. Yash Pal, A. K. Ray, and T. N. Rengarajan (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 28: 1177-89(June 16, 1963). (In English)

A study of particles emitted within a forward angle of 5° in collisions of 25-Bev/c protons with emulsion nuclei was made with a stack exposed in a pulsed magnetic field of 200 kilogauss. The momenta and the sign of charge for the secondary particles were determined by a measurement of magnetic curvature, after correcting for distortion. There is a large positive excess among the secondaries within this angular interval, and it increases with increasing secondary energy. The elasticity distribution of the surviving protons was obtained, and it is found that $\langle\eta\rangle = 0.41 \pm 0.05$. The average transverse momentum of proton is found to be $\sim(400 \pm 50)$ Mev/c. By using the variation of grain density with momentum, it was possible to identify the secondaries, and in this way the limit on the production of Σ^- relative to all baryons is obtained as $(2 \pm 1.5)\%$. The correlation between the multiplicity of an interaction and the energy given to the most energetic particle is also studied. (auth)

39863 HYPERON RESONANCE STATES AND K^--MESON CAPTURE ON COMPLEX NUCLEI. N. Kwak and J. Schneps (Tufts Univ., Medford, Mass.). Nuovo Cimento (10), 28: 1200-13(June 16, 1963). (In English)

A search for possible hyperon resonance states, which decay into $\Sigma^+\pi^-$ or $\Lambda\pi^-$ from K^--meson capture processes on complex nuclei, in view of the recent development of the hyperon resonances, was made. In order to establish the hyperon resonances; an extensive pion energy spectrum was studied in addition to the mass spectrum. A calculation, assuming that the pion scatters singly with a nucleon inside the nucleus, fits the pion and hyperon kinetic energy spectra and the excitation of the residual nucleus for the (Σ,π) events very well, if Y_0^* (1405 Mev, T = 0) production is taken into account. This model calculation also predicts the right position at about 100 Mev for the pion peak from the (Λ,π^-) channel. As a consequence of the pion spectrum study it seems to be clear that the K^--meson capture processes most likely occur uniformly inside the nucleus instead of on the surface of the nucleus. It is found that about 30 to 40 per cent of (Σ,π) events come through the Y_0^* resonance state. On the other hand, the estimate of Y_1^* (1385 Mev, T = 1) production could not be obtained due to poor statistics. (auth)

39864 INELASTIC INTERACTIONS OF 11.4 Gev/c π^--MESONS IN HYDROGEN. T. Ferbel and H. Taft (Yale Univ., New Haven and Brookhaven National Lab., Upton, N. Y.). Nuovo Cimento (10), 28: 1214-27(June 16, 1963). (In English)

Production cross sections and angular distributions of Λ and K^0 particles produced by 11.4 Bev/c π^- mesons in hydrogen were measured. A systematic investigation was made of all two-body decays of unstable neutral particles. No events inconsistent with γ, Λ, or K^0 were found. Production cross sections, angular distributions, and effective mass distributions of π mesons produced in 4-prong events were also measured. No evidence for dominance of any high-mass multi-pion resonance was found. Both the pion production and strange-particle production reactions demonstrated peripheral characteristics in that the baryon was strongly peaked backward in the center of mass. The average transverse momentum was observed to be a monotonically increasing function of mass. The experimental total interaction cross-section was (25.3 ± 1.5) mb. The effect of the pion-nucleon $T = 3/2$ isobar was clearly observed. (auth)

39865 "EFFECTIVE TARGET-MASS" IN INELASTIC INTERACTIONS OF 26.7 Gev/c PROTONS WITH NUCLEONS. Y. K. Lim (Univ. of Illinois, Urbana). Nuovo Cimento (10), 28: 1228-37(June 16, 1963). (In English)

The effective target-mass distribution was obtained for a sample of proton-free proton and proton-bound nucleon inelastic collisions. It indicates that at least half of the events are to be interpreted as central collisions. (auth)

39866 TWO EXAMPLES OF RARE MODES OF DECAY OF HYPERFRAGMENTS. S. N. Ganguli, N. Kameswara Rao, and M. S. Swami (Tate Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 28: 1258-71(June 16, 1963). (In English)

Two events, which appear to be rare decay modes of hyperfragments were observed in a stack of nuclear emulsions exposed to the 23-Bev/c proton beam of the proton synchrotron at CERN. The first event is interpreted as due to the muonic decay of a lithium hyperfragment and the second as due to the π^+-mesonic decay of a helium hyperfragment. (auth)

39867 COVARIANT STATISTICAL TREATMENT OF ANTIPROTON ANNIHILATION. J. McConnell and J. Shapiro (Fordham Univ., New York). Nuovo Cimento (10), 28: 1272-93(June 16, 1963). (In English)

Low energy experimental results for antiproton-proton annihilation are used to determine interaction volumes for pions and kaons. The information so obtained is utilized to make predictions for production of elementary particles, excluding isobars, for antiproton momenta 3 Bev/c, 6 Bev/c, and 9.14 Bev/c. (auth)

39868 POSITIVE AND NEUTRAL PION PHOTOPRODUCTION ANALYSIS. Ph. Salin (Faculté des Sciences, Bordeaux). Nuovo Cimento (10), 28: 1294-1317(June 16, 1963). (In English)

A covariant scattering amplitude is written including Born terms without multipole projections, pion-nucleon isobars, and two-pion contribution. The resonating phase shifts of the isobars are taken to satisfy a Breit and Wigner expression, and the bipion model is applied. A satisfactory fit is obtained from threshold to 800 Mev. It turns out that first and second resonance are mainly M_1^+ and E_2^-, respectively, and that one does not need the bipion contribution to explain experimental data. (auth)

39869 ON THE ANALYTIC CONTINUATION OF THE SCATTERING AMPLITUDE THROUGH A THREE-PARTICLE CUT. D. I. Olive (Cambridge Univ., Eng.). Nuovo Cimento (10), 28: 1318-36(June 16, 1963). (In English)

The analytic continuation of the scattering amplitude onto the sheet reached by encircling the lowest three-particle singularity in an anticlockwise direction is investigated by using generalized normal threshold discontinuity formulas derived from unitarity. The integral equation is not Fredholm because of the connectedness structure of the three-particle amplitude, but this difficulty is overcome by a manipulation that introduces extra integrations in which complex normal thresholds may occur. It is verified that if there is a two-particle state, 2′, with a particle in common with the three-particle state, then the normal threshold corresponding to the state, 2′, vanished on this particular three-particle sheet. Three-particle sheets reached by different routes are also considered. A hypothesis concerning the analytic structure of multiparticle amplitudes is used as a guide. (auth)

39870 BOUND STATES BY PURE REPULSIVE FORCES. J. Osada, Y. Hama, and D. M. Redondo (Univ. of São Paulo, Brazil). Nuovo Cimento (10), 28: 1337-41 (June 16, 1963). (In English)

Even in a system of many fermions interacting through pure repulsive potentials, it is possible for a pair of particles to form a kind of bound state, if the density of the system is sufficiently large. This phenomenon is caused by the strong pressure of the large number of particles surrounding the pair in question. (auth)

39871 ON THE REACTION n + d → 2n + p AND THE NUCLEON-NUCLEON INTERACTION. F. Ferroni (Università, Turin and Istituto Nazional di Fisica Nucleare, Turin) and V. Wataghin. Nuovo Cimento (10), 28: 1342-50(June 16, 1963). (In English)

A field-theoretical model is applied to the reaction n + d → 2n + p. The final-state interaction between a pair of nucleons at a time is taken into account. The fit with the experiment indicates that there is no bound singlet state of two neutrons. Some new measurements are suggested in order to improve the determination of the singlet neutron-neutron scattering length. (auth)

39872 INTERACTIONS OF 25 Gev PROTONS WITH PROTONS AND HEAVY NUCLEI IN NUCLEAR EMULSIONS. H. Meyer (Universität, Hamburg), M. W. Teucher, and E. Lohrmann. Nuovo Cimento (10), 28: 1399-1411 (June 16, 1963). (In English)

In nuclear emulsions 1226 interactions of 27 Bev and 20.5-Bev protons were found in a systematic way by track following. The mean free path is (35.1 ± 1.5) cm at 27 Bev and (35.6 ± 1.5) cm at 20.5 Bev. A list of the type of all interactions (N_h,N_s) is presented. A survey about the mean number of heavily ionizing tracks (N_h) and of shower particles (N_s) is given as a function of primary energy E. Between 1 Bev and 30 Bev for collisions in nuclear emulsions: $\langle N_s \rangle = 0.65(E_{kin}/Bev)^{0.7}$. Castagnoli's method to estimate the primary energy from the angular distribution of the shower particles was applied to interactions with $N_h \leq 1$. The true energy is overestimated by a factor which increases with decreasing multiplicity N_s. The interactions were separated into those on C, N, and O target nuclei and those on Ag and Br target nuclei. At a primary energy of 24 Bev the following dependence of the mean number of shower particles (N_s) on the atomic number A was found: $\langle N_s \rangle = 3.4 \times A^{0.14 \pm 0.03}$. This is consistent with the hydrodynamic theory of multiple meson production, but also with calculations assuming an intranuclear cascade. There are significant differences in the correlation N_h versus N_s for the two groups of target nuclei. (auth)

39873 ON THE ELECTROMAGNETIC INTERACTION WITH THE DEUTERON AT THRESHOLD. B. Bosco, G. Ciocchetti, and A. Molinari (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 28: 1427-36(June 16, 1963). (In English)

The method of analyticity and unitarity is applied to the determination of the magnetic dipole matrix element. It is shown how the computed radiative neutron capture is in agreement with experiment. The influence of the final-state interaction is discussed for the deuteron photodisintegration just above the threshold. Some comments are made on the application of the Siegert theorem. (auth)

39874 ASYMPTOTIC BEHAVIOR OF THE NUCLEON-NUCLEON SCATTERING AMPLITUDES ACCORDING TO THE MULTIPERIPHERAL MODEL. G. Costa (CERN, Geneva). Nuovo Cimento (10), 28: 1455-63(June 16, 1963). (In English)

The asymptotic behavior of the nucleon-nucleon elastic scattering amplitudes at high energy and small momentum transfer is derived in the framework of the multiperipheral model. The results agree with those obtained according to the reggeizing rules, except for the axial vector amplitude which differs in some peculiar features of physical interest. In particular, it requires the introduction of a new term, which is independent from the two coefficients exhibited by the π-N and by the other N-N amplitudes. The new term does not appear in the asymptotic expressions of the cross sections and polarization, but one can find other physical observables, e.g., the depolarization, in which it is present. (auth)

39875 SMALL-ANGLE PHOTOPRODUCTION OF SINGLE POSITIVE PIONS ON HYDROGEN AT ENERGIES AROUND THE "SECOND RESONANCE." M. Beneventano, R. Finzi, L. Mezzetti, L. Paoluzi, and S. Tazzari (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 28: 1464-83(June 16, 1963). (In English)

Cross sections of single positive pions produced in hydrogen by photons of laboratory energies between 550 and 900 Mev at center-of-mass angle between 0° and 10° were measured, using a magnetic spectrometer and an appropriate counter arrangement. The experiment is described in detail. Angular distributions at constant γ ray energy and the dependence of the differential cross section on energy at various constant center-of-mass angles are given and their significance discussed. (auth)

39876 A POSSIBLE INDICATION FOR "REGGE-POLE" BEHAVIOR OF THE PION. S. Nussinow (Israel Atomic Energy Commission, Rehovoth). Nuovo Cimento (10), 28: 1491-3(June 16, 1963). (In English)

The Treiman-Yang test for the one-pion exchange in the reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ is studied because of a possible indication for Regge-pole behavior in the pion.

Conditions for violation of this test are considered. (R.E.U.)

39877 THE Q_Λ-VALUE FOR HYPERFRAGMENT BINDING ENERGIES. B. Bhowmik and D. P. Goyal (Univ. of Delhi, India). Nuovo Cimento (10), 28: 1494-6(June 16, 1963). (In English)

The determination of the hyperon(Λ^0) mass (i.e., the Q-value in $\Lambda^0 \rightarrow p + \pi^-$ decay) is of great importance in the evaluation of Λ^0-binding energies, $_\Lambda B$, in hypernuclei. The weighted mean Q_Λ-value is obtained as $\overline{Q}_\Lambda = (37.60 \pm 0.12)$ Mev. The best value for the Λ^0 mass is given as $\overline{M}_\Lambda = (1115.40 \pm 0.13)$ Mev. The results of various methods for the determination are given. (R.E.U.)

39878 THE DECAY MODES $\eta^0 \rightarrow \gamma + e^+ + e^-$, $\eta^0 \rightarrow \gamma + \mu^+ + \mu^-$ AND $\eta^0 \rightarrow 2\pi + e^+ + e^-$. E. Celeghini and R. Gatto (Università, Florence and CNEN, Frascati, Italy). Nuovo Cimento (10), 28: 1497-1500(June 16, 1963). (In English)

Calculations are given for spectra and probabilities of the reactions $\eta^0 \rightarrow \gamma + e^+ + e^-$ and $\eta^0 \rightarrow \gamma + \mu^+ + \mu^-$. The decay mode $\eta^0 \rightarrow 2\pi + e^+ + e^-$ is also discussed. The quantum numbers assumed for η^0 are J = 0, P = −1, I = 0, C = G = +1. (R.E.U.)

39879 A UNITARY SYMMETRY MODEL FOR PHOTOPRODUCTION. L. Holloway and A. Fujii (CNEN, Frascati, Italy). Nuovo Cimento (10), 28: 1517-21(June 16, 1963). (In English)

The photoproduction of pseudoscalar mesons is considered from the viewpoint of unitary symmetry. The known particles and resonances are assigned to irreducible representations of a group, which satisfies the Lie Algebra. Results are obtained in the form of relations between the amplitudes for various photoproduction process. (R.E.U.)

39880 COMPETITION BETWEEN MESON AND BARYON EXCHANGE IN PERIPHERAL COLLISIONS. G. Alexander (Israel Atomic Energy Commission, Rehovoth) and G. Yekutieli. Nuovo Cimento (10), 28: 1522-6 (June 16, 1963). (In English)

Two reactions $\bar{p} + p \rightarrow K^+ + K^-$ and $\bar{p} + p \rightarrow \overline{\Lambda} + \Lambda$ at $P_{\bar{p}} = 1.6$ Bev/c were studied in terms of peripheral collisions in order to clarify the relative strength of different exchange diagrams. Meson and baryon exchange is considered in π^+-p, π^+ N, and K^--p interaction diagrams. The K^- and $\overline{\Lambda}$ are highly peaked in the direction of $\bar{p}$ in the reactions. (R.E.U.)

39881 π^+-DECÁY OF HYPERNUCLEUS AND PIONIC Σ-DECAY AMPLITUDES. N. N. Biswas (Max-Planck-Institut fur Physik und Astrophysik, Munich). Nuovo Cimento (10), 28: 1527-9(June 16, 1963). (In English)

The case of hypernuclei decay by the emission of a π^+ meson is possible because the Λ bound inside the hypernucleus can have a transition to virtual Σ state and then decay from this state. The rate of hypernucleus decay from the virtual Σ state is estimated. Mesic and nonmesic weak decay of the hypernucleus is considered. (R.E.U.)

39882 AN INTERACTION OF A HYPERON OF STRANGENESS −2. B. Bhowmik (Univ. of Delhi, India). Nuovo Cimento (10), 29: 1-7(July 1, 1963). (In English)

An example of interaction of an identified Ξ^- hyperon at rest in nuclear emulsion, is reported. Two hypernuclei are produced at the capture star; one is unambiguously identified as H^4 hypernucleus from its characteristic decay mode, $_\Lambda H^4 \rightarrow He^4 + \pi^-$, the second one is most probably a $He^{4,5}$ hypernucleus decaying in the non π^--mesic mode. The hyperon is produced in a disintegration caused by a K^- meson of momentum, 1.5 Bev/c. Additional evidence for the strangeness value of the hyperon is obtained from the analysis of the parent K^- star. A charged K meson is emitted in the production process, which on the grounds of strangeness and energy balance in the reaction proves the strangeness −2 of the hyperon. (auth)

39883 HYPERON AND KAON PRODUCTION BY 24.5 Gev/c PROTONS ON PROTONS. J. Bartke (CERN, Geneva), W. A. Cooper, B. Czapp, et al. Nuovo Cimento (10), 29: 8-18(July 1, 1963). (In English)

An analysis is given of strange-particle production in collisions of 24.5 Bev/c protons with protons (c.m.s. total energy = 6.72 Bev). It is based on 50,000 pictures taken with the CERN 30 cm hydrogen bubble chamber. Comparison is made with an experiment on π^--p interactions at 16 Bev/c in the same chamber. The low transverse momenta previously found are confirmed; only positive hyperons have high transverse momenta. Partial cross sections are given. (auth)

39884 HYPOTHETICAL VORTEX MODEL FOR ELEMENTARY PARTICLES. M. Hamaguchi (Tokushima Univ., [Japan]). Nuovo Cimento (10), 29: 40-52(July 1, 1963). (In English)

Elementary particles are assumed as innumerable small globular rotating eddies in the continual media. For the motion of such a hypothetical globular eddy, the medium elements of this eddy are rotating about the center of gravity of the hypothetical eddy which moves to follow the macroscopic trajectory of a rotating eddy in the medium. For the constituent of this medium, use is made of the two kinds of matter consisting of the perfect and the viscous fluids. The characteristic properties in each of the above cases are extracted from the standpoint of the covariant relativistic hydrodynamics, and a model of multiple particle production is proposed. (auth)

39885 RENORMALIZATION OF A BOSON DOUBLET IN INTERACTION WITH A FERMION DOUBLET. J. P. Adam and B. Jouvet (Laboratoire de Physique Atomique et Moléculaire, Paris). Nuovo Cimento (10), 29: 53-68 (July 1, 1963). (In French)

A study is made of the renormalization of a system in which two bosons of the same tensorial type interact with two different pairs of unlike fermions. The renormalization constants of the vertices are first explicitly defined. Then, to renormalize the two boson fields and boson masses, 3 + 3 renormalization constants are required. These are determined explicitly as a function of the unrenormalized vacuum polarization operators. A prescription for the renormalization of these operators is given. The high-energy limits of the boson propagators are related to the field renormalization constants. The resulting formulae generalize, in matrix form, the usual formulae for the single boson theory. Some care must be taken for the generalization to the case of unstable bosons. The case of two bosons interacting with a single pair of fermions is also briefly discussed. (auth)

39886 A PHENOMENOLOGICAL ANALYSIS OF THE K_{l3} DECAYS. J. Iizuka and A. Toda (Tokyo Univ. of Education). Nuovo Cimento (10), 29: 163-82(July 1, 1963). (In English)

A phenomenological analysis of the three-body leptonic decays of the K meson is made under the recently established facts that neither the $|\Delta I| = \frac{1}{2}$ rule nor the $\Delta S = \Delta Q$ rule are valid in the decays of the strange particles. The main interest of this analysis is to obtain an idea of the relative magnitudes of the independent form factors in the processes, where the form factors are taken to be real constants (the time-reversal invariance is assumed). In this connection, the weak Hamiltonian is assumed to be the

simplest one, i.e., it is the usual lepton current times the strangeness nonconserving vector current. The latter includes both the $|\Delta I| = 1/2$ and $3/2$ parts and that the $|\Delta I_3| = 1/2$ and $3/2$ components in the $|\Delta I| = 3/2$ current may be coupled to the lepton current with the different strengths. Thus the over-all K_{l3}-decays can be described by the four parameters in addition to the effective coupling constant. These parameters are estimated from the up-to-date available data. The unique set of their values is not obtained from the present data, however it is shown that we can get certain restrictions for their magnitudes. A possible unique choice of the parameter set from many consistent ones is discussed in relation with the muon energy spectrum of the $K^+_{\mu 3}$ decay and future experiments. The results are discussed from the dispersion relation and the view-point of the quasi conserved current. (auth)

39887 REGGE POLE IN HIGH-ENERGY NEUTRINO REACTIONS. D. Tadić (Univ. of Birmingham, Eng.). Nuovo Cimento (10), 29: 183-91(July 1, 1963). (In English)

Neutrino-nucleon scattering is analyzed on the assumption that it is dominated by a Regge pole associated with an intermediate vector boson. (auth)

39888 REGGE POLES AND THE PRODUCTION OF HIGH-ENERGY PARTICLES BY γ-RAYS. A. P. Contogouris (Nuclear Research Centre "Democritos", Athens). F. Hadjioannou and T. Kinoshita. Nuovo Cimento (10), 29: 192-200(July 1, 1963). (In English)

If exchanged particles in a peripheral collision are Regge objects, the cross section at forward angles will differ in a specific way from what is predicted by the ordinary peripheral model. Thus, experiments of peripheral collision type may be used to test the Regge pole hypothesis in particle physics. The photoproduction of high-energy particles in the forward direction is examined from this point of view. (auth)

39889 ON THE DEUTERON WAVE FUNCTION. G. Bialkowski (CERN, Geneva). Nuovo Cimento (10), 29: 201-15(July 1, 1963). (In English)

The deuteron wave function in both S and D states is constructed following Martin's method in such a way that the full OPE term (scalar and tensor forces) is completed by few phenomenological terms. It is shown that the function fulfills all the deuteron data when and only when the NNπ coupling constant is not too different from its well-known value 0.08. (auth)

39890 A NOTE ON AN ISOSCALAR $K\bar{K}$ RESONANCE. I. M. Barbour and K. Nishimura (Università, Rome). Nuovo Cimento (10), 29: 288-90(July 1, 1963). (In English)

A one-channel problem is considered in the generation of ϕ mesons by the isoscalar $K\bar{K}$ resonance. The coupling constants $\gamma^2_{K\bar{K}\phi}$ and $\gamma^2_{K\bar{K}\rho}$ are computed, and their ratio is found to be in agreement with the prediction of the octet model of unitary symmetry. The deduced width of the resonance of the ϕ meson is also in good agreement with experiment. (R.E.U.)

39891 ON THE POSSIBILITY OF RESONANT INTERACTIONS OF THE MUON. G. von Gehlen (CNEN, Frascati, Italy). Nuovo Cimento (10), 29: 295-7(July 1, 1963). (In English)

An attempt to ascribe the mass difference between the muon and the electron is made by anomalous interactions in muon electrodynamics. It is assumed that the number of muons and muon neutrinos is conserved in the classification of possible resonant states which interact with the muon according to their muon number N_μ. (R.E.U.)

39892 PREACCELERATION IN ELECTRON THEORY. M. N. Hack (Argonne National Lab., Ill.). Nuovo Cimento (10), 29: 298-301(July 1, 1963). (TID-17607; UAC-6971) (In English)

The phenomenon of preacceleration or precognitive response of an electron in classical Lorentz-Dirac theory is discussed. This occurs when the electron reacts to an applied force before the onset of the force. (R.E.U.)

39893 γ_5-INVARIANCE AND FERMION MASS. C. R. Hagen. Nuovo Cimento (10), 29: 306-8(July 1, 1963). (In English)

The distinction between the role of the boson mass in gauge-invariant theories and fermion mass in γ_5-invariant theories is shown. (R.E.U.)

39894 K^--2N INTERACTION MECHANISM. M. D. Warty (Univ. of Delhi). Nuovo Cimento (10), 29: 309-10 (July 1, 1963). (In English)

It is proposed that a resonant state can be responsible for the K^--2N interactions in nuclear emulsions. The K^- interactions are considered with He^4 and deuterium separately. (R.E.U.)

39895 MESON EXCHANGE IN THE REACTION $K^+ + p \rightarrow K^* + N^*$. G. Goldhaber, W. Chinowsky, S. Goldhaber, W. Lee, and T. O'Halloran (Univ. of California, Berkeley). Phys. Letters, 6: 62-6(Aug. 15, 1963). (In English)

The four-particle final states of the K^+-p interaction at 1.96 Bev/c were investigated. It is found that these states are predominantly produced via the double resonance production $K^+ + p \rightarrow K^* + N^*$. The experimental data support a spin-zero meson exchange, presumably a meson(π), for small four-momentum transfers. The four particles produced in the reaction are in the isotopic spin $T = 1$ state and occur in five possible charge combinations. The observed cross sections of these reactions and the branching ratios expected on the assumption that the nucleon and meson(π) are always produced in the $T = 3/2$ state and that the meson (K) and (π) are always produced in the $T = 1/2$ state are presented. (C.E.S.)

39896 ON A METHOD OF MASS DETERMINATION FOR THE MUON-NEUTRINO. P. Dennery and H. Primakoff (Univ. of Pennsylvania, Philadelphia). Phys. Letters, 6: 67-9(Aug. 15, 1963). (In English)

Experiments were performed to refine the upper limit on the mass of the muon-neutrino. The experiments consisted of investigating the shape of the high energy end of the meson (μ^-) or proton spectra in the $\Lambda \rightarrow p + \mu^- + \nu_\mu$ process. Other experiments consisted of investigating the shape of the high energy end of the photon spectrum in $\pi^+ \rightarrow \gamma + \mu^+ + \nu_\mu$ and the shape of the high energy end of the meson (μ^+) spectrum in $K^+ \rightarrow \pi^0 + \mu^+ + \nu_\mu$. Experimental data are given. (C.E.S.)

39897 EXPERIMENTAL TEST FOR REGGE CUTS. Keiji Igi and V. L. Teplitz (Univ. of California, Berkeley). Phys. Letters, 6: 73-4(Aug. 15, 1963). (In English)

The utilization of polarization measurements in detecting Regge cuts was discussed. The general case of boson-nucleon scattering was considered. It was assumed that the important contributions to the scattering amplitude were the Pomeranchuk trajectory, the next nearest pole trajectory, and the cut associated with the unitarity iteration of the Pomeranchuk trajectory. From polarization formulas a test to determine whether a singularity is a pole or a cut is derived. The test depends only on the width of the forward peak in the differential cross section. Nucleon-nucleon and meson(π)-proton scattering were also discussed. (C.E.S.)

39898 THE ANALYSIS OF TWO-PION RESONANCES IN TWO-PRONG π^--p INTERACTIONS AT 7–8 Gev. H. Hulubei (Bucharest State Univ.), C. Besliu, T. Besliu, et al. Phys. Letters, 6: 77-9(Aug. 15, 1963). (In English)

Two-prong events from π^--p interactions in a propane bubble chamber exposed to a 7–8 Bev π^- beam were investigated. The mass of the $\pi^+\pi^-$ system was calculated for all events and the resulting distributions were presented. In order to explain the experimental distribution as a sum of resonance and Monte Carlo distributions it was necessary to consider a new resonance with a mass of 922 ± 30 Mev and a width of 150 Mev. (C.E.S.)

39899 PROTON-PROTON SCATTERING IN THE Gev REGION. E. H. Auerbach (Brookhaven National Lab., Upton, N. Y.) and G. E. Brown. Phys. Letters, 6: 95-7 (Aug. 15, 1963). (BNL-7173). (In English)

It is pointed out that the disappearance of the hard core in proton-proton elastic scattering in the 1–10 Bev region can account for the transient shrinking in the differential cross section. (C.E.S.)

39900 REMARKS ON PROTON-COMPTON SCATTERING. A. P. Contogouris (N.R.C. "Democritos" and Center for Advanced Study of Physics, Athens) and A. Verganelakis. Phys. Letters, 6: 103-5(Aug. 15, 1963). (In English)

Contributions for meson (η^0) and two-meson (π) exchange in proton-Compton scattering are considered. It is shown that these exchange effects may well be responsible for the disagreement between the dispersion theoretical predictions and experimental data in the photon energy region 150–230 Mev. The differential cross sections for unpolarized photons and photons polarized perpendicular or parallel to the plane of scattering are presented to illustrate the exchange contributions. (C.E.S.)

39901 AN ESTIMATE OF THE CORRECTION TO THE STRIP-APPROXIMATION FROM INELASTIC UNITARITY. D. Morgan (Rutherford High Energy Lab., Chilton, Berks, Eng.). Phys. Letters, 6: 106-8(Aug. 15, 1963). (In English)

Corrections to the strip-approximation for π-π scattering obtained from inelastic unitarity are presented. The method consists in identifying the quantity yielded by the strip-approximation for the inelastic absorptive part as the imaginary part of the two-body K-matrix. (C.E.S.)

39902 EVIDENCE FROM ELECTRON SCATTERING ON THE ELEMENTARY NATURE OF THE PHOTON. K. Berkelman, M. Feldman, and G. Rouse (Cornell Univ., Ithaca, N. Y.). Phys. Letters, 6: 116-18(Aug. 15, 1963). (In English)

The differential cross section for the elastic scattering of electrons by protons was measured at angles between 18 and 90° and for values of the invariant momentum transfer squared of 4 and 10 fm^{-2} in an attempt to detect the effects of the recently suggested Regge pole nature of the photon. The cross sections were in agreement with the predictions of the Rosenbluth formula derived on the assumption that the scattering takes place through the exchange of a single elementary spin-one photon. (C.E.S.)

39903 SCATTERING OF LIGHT BY LIGHT. V. M. Harutyunyan, F. R. Harutyunyan, K. A. Ispiryan, V. A. Tumanyan (Physical Inst. of the State Committee on the Use of Atomic Energy, Erevan, Armenia, USSR). Phys. Letters, 6: 175-6(Sept. 1, 1963). (In English)

An investigation of the dependence of the photon-photon cross section on photon energy and frequency, along with estimates on the registration frequency of scattering events, indicates that light scattering by light is observable using modern intensities of laser radiation and bremsstrahlung from high-energy electron accelerators. (D.C.W.)

39904 ON THE MASS DIFFERENCE OF THE ELECTRON AND THE MUON. P. Pascual (Junta de Energía Nuclear, Madrid). Phys. Letters, 6: 184-5(Sept. 1, 1963). (In English)

The concept of hidden symmetries is used to prove (seemingly) that the mass difference can arise entirely from the electromagnetic interactions. (D.C.W.)

39905 PROTON SPECTRA IN Λ^0 BETA DECAY. C. Baglin (Ecole Polytechnique, Paris), V. Brisson, A. Rousset, et al. Phys. Letters, 6: 186-9(Sept. 1, 1963). (In English)

The proton transverse momentum and kinetic energy spectra obtained by analysis of $\Lambda^0 \rightarrow p + e^- + \nu^-$ decays in a heavy-liquid bubble chamber exposed to a 1.45 Bev/c K^- beam are compared with several theoretical spectra. The electron and neutrino momentum spectra are treated similarly. V-A theory gives the best fit to the data. (D.C.W.)

39906 INVESTIGATION OF INELASTIC INTERACTIONS IN π^--p COLLISIONS AT 2.8 GeV/c. Yu. V. Trebukhovskii, I. A. Erofeev, and G. D. Tikhomirov (Inst. of Theoretical and Experimental Physics, Moscow). Phys. Letters, 6: 190-3(Sept. 1, 1963). (In English)

The interaction, $\pi^- + p \rightarrow p + \pi^- + m\pi^0$, of 2.8 Bev/c mesons ($\pi^-$) with free and quasi-free protons was investigated using a 17-liter bubble chamber with no magnetic field. The cross section of meson (ρ^-) production in the reaction $\pi^- + p \rightarrow p + \rho^-$ in the momentum transfer region 0.2 to 0.4 Bev/c was determined to be 0.3 ± 0.07 mb. Two explanations are proposed for an irregularity observed in the missing mass distribution near 1 Bev for mesons (π^-) at 2.8 Bev/c. (D.C.W.)

39907 PRODUCTION OF $\Sigma\pi$ PAIRS BY K^- STOPPING IN EMULSION. A. Samman, J. P. Gerber, and H. Braun (Centre de Recherches Nucléaires Strasbourg-Cronenbourg). Phys. Letters, 6: 200-3(Sept. 1, 1963). (In French)

The mass and momentum distributions of stars having Σ-π pairs were obtained and were resolved into distributions for events involving heavy nuclei, light nuclei, and light nuclei with recoil. The results support Barbaro's observations on the distribution of the events and the state of the residual nuclei. The momentum distributions support Frisk's observations indicating Y_0^* production in these interactions. (D.C.W.)

39908 A POSSIBLE GENERALIZATION OF POMERANCHUK THEOREM AND ITS CONSEQUENCES IN SU_3 SYMMETRY. Mahiko Suzuki (Tokyo Univ.). Phys. Letters, 6: 204-5(Sept. 1, 1963). (In English)

The assignment of Pomeranchuk matter to a basis of a representation of the SU_3 group is discussed, and the scattering between two particles belonging to the 8-dimensional representation of SU_3 is considered. Relations among the high energy total cross sections are obtained, as well as the factorization theorem. (D.C.W.)

39909 THE S-WAVE Λ-Λ INTERACTION. Hiroshi Nakamura (Tokyo Inst. of Tech.). Phys. Letters, 6: 207-8 (Sept. 1, 1963). (In English)

A variational principle was used to estimate the Λ-Λ interaction from the observed binding energy $B_{\Lambda\Lambda}$ = 17.5 ± 0.4 Mev of the double hypernucleus $_{\Lambda\Lambda}Be^{10}$. The results indicate that the Λ-Λ interaction is very weak and that a strong (attractive) Λ-Λ force is not favored,

at least for $_{\Lambda\Lambda}Be^{10}$. If the hyperfragment is really $_{\Lambda\Lambda}Be^{11}$, the conclusions are reversed. (D.C.W.)

39910 THE ISOTOPIC SPIN OF THE f_0 RESONANCE. P. G. Murphy (Rutherford Lab., Chilton, Berks, Eng.). Phys. Letters, 6: 208(Sept. 1, 1963). (In English)

A T = 1 resonance has been used to explain the observation of a peak at a mass of 1250 Mev/c^2 in the invariant mass spectrum of pion pairs from $\pi^- - p \rightarrow \pi^+ + \pi^- + n$ and the absence of a peak in the π^--π^0 spectrum from $\pi^- p \rightarrow \pi^- + \pi^0 + p$. It is shown that this explanation is untenable since the resonance can not occur in either the T = 1 or T = 2 state. Therefore, the f^0 resonance has isotopic spin T = 0. (D.C.W.)

39911 ON THE TOTAL CROSS SECTIONS FOR REACTIONS WITH POLARIZED BEAMS AND POLARIZED TARGETS. S. M. Bilenkii and R. M. Ryndin (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 6: 217-18(Sept. 1, 1963). (In English)

Relations by which initial system states, imaginary elastic scattering amplitudes, differential elastic scattering cross sections, and parities of the involved particles can be determined from the total cross sections for reactions of polarized beams with polarized targets are derived. The collisions of two spin-½ polarized particles are considered. (D.C.W.)

39912 $K^+ + p \rightarrow K^0 + \pi^+ + p$ AT 1.14 Gev/c. J. Duboc (Collège de France, Paris), N. H. Duong, P. Eberhard, R. George, V. P. Henri, F. Levy, J. Popyen, and M. Pripstein. Phys. Letters, 6: 233-6(Sept. 1, 1963). (In English)

An analysis of the (π^+-p) mass distribution showed that the data were dominated by an N^*_{33} resonance with a mass of 1212 ± 8 Mev and a width of 72 ± 13 Mev. The production, decay, and spin orientation of this resonance were examined. The data are also consistent with no K^* (730 Mev) contribution. Evidence for the presence of a K^* (888 Mev) in the data with no interference between K^* and N^*_{33} was obtained. (D.C.W.)

39913 TWO-BODY INTERACTIONS AND THE NILSSON POTENTIAL. S. Moszkowski (Univ. of California, Los Angeles). Phys. Letters, 6: 237-8(Sept. 1, 1963). (In English)

The consideration of a simple example strongly suggests that in calculations with the Nilsson Model the total energy should be written as a simple sum of eigenvalues, even with two-body interactions. (D.C.W.)

39914 POLE APPROXIMATION MODEL IN τ, τ' AND η DECAY AND K-π DIRECT COUPLING CONSTANT. E. Eberle and S. Iwao (Universita, Genoa and Istituto Nazionale di Fisica Nucleare, Genoa). Phys. Letters, 6: 238-40(Sept. 1, 1963). (In English)

The direct K-π coupling constant is evaluated by applying the pole-approximation model to the τ, τ', and η decays. The angular distribution of the π^+-π^0 scattering is also calculated from the τ' decay spectrum. The results of the calculations support the reliability of the pole approximation for the treatment of the decays. (D.C.W.)

39915 TWO-FIELD COUPLINGS WITH ESPECIAL REFERENCE TO PHOTON-NEUTRAL MESON INTERACTION. G. Feldman and P. T. Matthews (Imperial Coll. of Science and Tech., London). Phys. Rev., 132: 823-30 (Oct. 15, 1963).

The coupling of two particles of identical quantum numbers, apart from their mass, is considered. It is shown that the effects of direct transitions of one particle into another can be treated exactly in terms of six parameters. These can be taken to be the true masses, the mixing parameters, and the partially renormalized coupling constants. This is a generalization of conventional mass renormalization for a single field. The special case of a photon and a neutral vector meson is discussed. Resonance effects may occur if the photon is virtual. However, gauge invariance and the vanishing of the photon mass forbid such effects for real photons, unless a dynamical accident relates the bare photon mass to the effective photon-meson couplings in a particular way. (auth)

39916 PHOTOPRODUCTION OF π^+ MESONS FROM HYDROGEN. M. J. Bazin and J. Pine (Stanford Univ., Calif.). Phys. Rev., 132: 830-6(Oct. 15, 1963).

The differential cross section for π^+ photoproduction was determined at 19 points, at center-of-mass angles from 30 to 150 deg, and at photon energies from 162 to 225 Mev. The data are concentrated near 180 Mev, where a full angular distribution was determined. The relative values of the cross sections are accurate to 5% or better, and the absolute normalization is accurate to 4%. The experiment provides data of improved accuracy that are in general consistent with previous results. The extrapolation to threshold gives a value for $(k^*/p^*)(d\sigma/d\Omega)^*$ at threshold of 16.1 ± 0.7 μb/sr, where k^*, p^*, and $(d\sigma/d\Omega)^*$ are the photon energy, pion momentum, and differential cross section, all in the center-of-mass system. (auth)

39917 THEOREM ON THE SHRINKING OF DIFFRACTION PEAKS. Albert C. Finn (Stanford Univ., Calif.). Phys. Rev., 132: 836-7(Oct. 15, 1963).

It is shown that the width of a diffraction peak divided by $\frac{1}{2}\sigma(s,t=0)$ cannot decrease faster at high energies than a constant times $(\ln s)^{-4}$. This follows from unitarity and analyticity in the largest Lehmann ellipse consistent with perturbation theory. (auth)

39918 $\gamma + p \rightarrow \eta + p$ REACTION AT LOW ENERGY AND THE SECOND-RESONANT STATE IN THE NUCLEON. Shigeo Minami and Tom A. Moss (Louisiana State Univ., Baton Rouge, La). Phys. Rev., 132: 838-40(Oct. 15, 1963).

The $\gamma + p \rightarrow \eta + p$ reaction near threshold is studied from field-theoretical viewpoint by taking into account the effects of the second resonant state of the nucleon. It is pointed out that there may be some possibility of strong d-wave η-N interaction at low energy. (auth)

39919 THREE-PHOTON DECAY OF POSITRONIUM ^1S STATE AS A TEST OF CHARGE CONJUGATION INVARIANCE. Joseph Schechter (Univ. of Rochester, N. Y.). Phys. Rev., 132: 841-4(Oct. 15, 1963).

In order to make comparisons with a possible experiment to test charge conjugation invariance, the angular distribution of decay photons is estimated for the forbidden 3γ decay of the ^1S state of positronium using the simplest matrix element satisfying Lorentz, gauge, and TCP invariance. (auth)

39920 ELASTIC SCATTERING OF PSEUDOSCALAR MESONS AND SU_n SYMMETRY. Donald E. Neville (Univ. of California, Berkeley). Phys. Rev., 132: 844-51(Oct. 15, 1963).

The crossing matrix for scattering $X_n + X_n \rightarrow X_n + X_n$ of a multiplet of scalar mesons X_n which transform according to the regular representation of SU_n, for all n is derived. For n = 3, or octet symmetry, in the limit of neglecting inelastic coupled channels it is found that, if the $J^P = 1^-$ 8′ channel resonates, so also should the other two 1^- channels 10 and $\overline{10}$. These decuplets resonate at essentially the same mass as the 8′, barring what are probably small corrections from crossed 0^+ channels 8 and 27. Similarly, for general

n, all $J^P = 1^-$ channels should resonate together. Application of the Gell-Mann and Okubo mass-splitting formula to the degenerate 8′, 10, and $\overline{10}$ leaves the 10 and $\overline{10}$ in energy regions that were explored in experiments, at least if one assumes the 725-Mev (Kπ) resonance is a member of the decuplet. However, effects from coupled inelastic channels such as $X_n + V_n \rightarrow X_n + V_n$ (V_n is $J^P = 1^-$ multiplet) may remove the mass degeneracy in the limit before symmetry-breaking effects are introduced. The crossing relations for $n = 3$ and $V_3 = 8'$, 10, $\overline{10}$ are examined and shown to be consistent with this explanation. For $n = 3$, the $X_3 + X_3 \rightarrow X_3 + X_3$ crossing relations favor a pseudoscalar, rather than a scalar octet X_3. (auth)

39921 HIGH-ENERGY BEHAVIOR IN PRODUCTION PROCESSES. I. G. Halliday and J. C. Polkinghorne (Cambridge Univ., Eng.). Phys. Rev., 132: 852-5(Oct. 15, 1963).

Regge pole-like terms in the high-energy behavior of production amplitudes are evaluated by using the leading asymptotic behavior of sums of Feynman diagrams. The forms obtained depend on the way variables are allowed to tend to infinity. (auth)

39922 LOW-ENERGY $\overline{K}$–d SCATTERING. Anand K. Bhatia and Joseph Sucher (Univ. of Maryland, College Park). Phys. Rev., 132: 855-62(Oct. 15, 1963).

The magnitude of recoil and binding effects in the multiple-scattering corrections to the impulse approximation in low-energy $\overline{K}$-d scattering is examined by the introduction of a model that makes tractable the numerical evaluation of the double-scattering terms. The finite mass of the nucleons and the n-p interaction in continuum states are both taken into account. It is concluded that estimates of multiple-scattering corrections that ignore these effects are not reliable. The model is used to compute the sum of the cross sections for $K^- + d \rightarrow K^- + d$, $K^- + d \rightarrow K^- + p + n$. Comparison with the rather limited data available in the region 100 to 200 Mev/c favors the so-called solution II found by Humphrey and Ross in their analysis of $\overline{K}$-p data based on the Dalitz scattering lengths. A pseudopotential or optical-model-like approach to meson-deuteron scattering, which may be useful in other problems, is also described. (auth)

39923 LOW-MOMENTUM-TRANSFER PION-PION SCATTERING. Louis A. P. Balazs (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 132: 867-73(Oct. 15, 1963). (BNL-7073)

High-energy effects at low momentum transfer, both in the direct and in the crossed channel, are introduced into a self-consistent calculation of low-energy π-π scattering. These effects are assumed to be dominated by top-level Regge trajectories. The general method consists of combining the generalized Chew-Mandelstam and Ball-Wong techniques with self-consistency. It can be extended to complex angular momenta and thereby used to calculate the parameters of the assumed Regge trajectories. A rough self-consistent calculation gives a mass of 712 Mev and a half-width of about 75 Mev for the ρ meson, and a value of 15 mb for the total cross section at very high energies. (auth)

39924 THREE-MESON MODEL OF p-p SCATTERING AND REGGE POLES. Riazuddin (Panjab Univ., Lahore) and Fayyazuddin. Phys. Rev., 132: 873-7(Oct. 15, 1963).

By considering a dispersion relation for that amplitude of p-p scattering, whose imaginary part in the forward direction is related to the total cross section, it is shown that the one-meson-exchange model and high-energy behavior of the p-p and p-$\overline{p}$ scattering cross sections as given by the Regge pole hypothesis, are consistent with the existing p-p scattering data. In the demonstration the energy range involved is larger than previously used in the demonstration of either of the above two aspects of p-p scattering. Further by considering a dispersion relation and high-energy behavior of another amplitude of p-p scattering, it is shown that the second type of coupling of the Pomeranchuk pole is zero. This reduces the number of unknown parameters in the expression for polarization at high energy. (auth)

39925 SOME EQUIVALENT APPROACHES TO THE SELF-CONSISTENT BOUND STATE OF STRONGLY INTERACTING PARTICLES. R. M. Rockmore (Brandeis Univ., Waltham, Mass.). Phys. Rev., 132: 878-83(Oct. 15, 1963).

It is shown that the method known as the unsubtracted bootstrap, by which one calculates the mass and residue of a self-consistent bound state of strongly interacting particles in the N/D formalism, may be identified with the requirements that the strong-vertex (Z_v) and wave-function (Z_3) renormalization constants of the composite vanish simultaneously. The unsubtracted bootstrap is also shown to be equivalent to the self-consistent bound-state model of Liu by identifying the first vertex equation of that model with $Z_v = 0$, and by reducing the second vertex equation to the statement $Z_3 = 0$ through the application of a Ward identity. The proof of equivalence is confined to S-wave bound states in the lowest order of self-consistency. (auth)

39926 GROUND-STATE ENERGY OF A TWO-NUCLEON SYSTEM. Gerald L. Nutt (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Rev., 132: 884-93(Oct. 15, 1963).

The ground-state energy of a system composed of an arbitrary number of nucleons coupled to a meson field is investigated. In the investigation, the nucleons are treated as an external source coupled to the meson field. Thus, only the mesons are treated as a quantum field and the ground-state energy is the energy of the zero-meson state. By using Fredholm determinants, the energy of the zero-meson state for the coupled source-field system is calculated relative to the energy of the zero-meson state for the noninteracting source-field system. The ground-state energy of this system is used to define the two-nucleon potential. This potential is calculated for two static nucleons coupled to a neutral scalar field and to a symmetric pseudoscalar field. In the case of the neutral scalar field, the well-known exact result is obtained. For the symmetric pseudoscalar field, the result is in good agreement with the potential studied by Gartenhaus. (auth)

39927 DERIVATION OF PARTIAL AMPLITUDES AND THE VALIDITY OF DISPERSION RELATIONS FOR PRODUCTION PROCESSES. D. Branson, P. V. Landshoff, and J. C. Taylor (Cambridge Univ., Eng.). Phys. Rev., 132: 902-12(Oct. 15, 1963).

Certain desirable requirements lead to an essentially unique definition for partial-wave amplitudes in production processes. This definition is given in concrete form and the case of particles with spin is treated. An application is included as an example of the usefulness of the partial amplitudes. A dispersion relation is given that is satisfied by the complete amplitude and probably also by the partial amplitudes. (auth)

39928 LEGENDRE TRANSFORMS AND KHURI REPRESENTATIONS OF SCATTERING AMPLITUDES. R. J. Eden (Cambridge Univ., Eng.). Phys. Rev., 132: 912-13 (Oct. 15, 1963).

A representation of a scattering amplitude is described in which asymptotic behavior of the Regge type is exhibited in crossing symmetric form. It is based on Legendre transforms, which have similar meromorphy properties to partial wave amplitudes but use variables of the type $(s - 2m^2)/2m^2$ instead of the cosine of the scattering angle. The representation obtained is another example of a class that has similar features to the crossing symmetric Sommerfeld-Watson transformation developed by Khuri and based on coefficients of a power series. (auth)

39929 REGGE POLES, POWER SERIES, AND A CROSSING-SYMMETRIC WATSON-SOMMERFELD TRANSFORMATION. N. N. Khuri (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 132: 914-26(Oct. 15, 1963).

It is shown that there exists a close relationship between the analytic properties of the partial-wave amplitude as a function of complex-angular momentum l and those of the coefficients of expansions, other than the partial-wave expansion, as functions of the corresponding summation index, ν. The case of power series in z, and in the Mandelstam variables t and u is studied in detail. It is shown how the l-plane Regge poles for $\mathrm{Re}l > -\frac{1}{2}$ determine all the ν-plane poles for $\mathrm{Re}\nu > -\frac{1}{2}$ and vice versa. For the relativistic amplitude a representation consisting of three double power series in s, t, and u is used. The analytic properties of the expansion coefficients in the two index variables that are implied by Regge analyticity in the l plane of each channel are established. This enables one to apply the Watson-Sommerfeld transformation twice and obtain a crossing-symmetric Regge-type representation that simultaneously displays the contributions of the Regge poles in all three channels. (auth)

39930 ANOMALOUS THRESHOLDS AND THREE-PARTICLE UNITARITY INTEGRAL. Y. S. Kim (Univ. of Maryland, College Park). Phys. Rev., 132: 927-9(Oct. 15, 1963).

Anomalous thresholds of the square diagram and their effect on the two-particle unitarity integral are discussed. It is shown for a certain diagram that the three-particle unitarity integral does not have counter terms that cancel the singularity from the two-particle contribution. Consistency with the crossed-channel unitarity is also discussed. (auth)

39931 DISCUSSION OF THE DYNAMICAL EQUATIONS FOR THE REGGE PARAMETERS. Hung Cheng (California Inst. of Tech., Pasadena). Phys. Rev., 132: 931-5(Oct. 15, 1963).

The dynamical equations for the Regge parameters in the relativistic, many-channel case are reduced into a single integral equation for $\mathrm{Im}\alpha(t)$, which is convenient to solve numerically. The solution of this integral equation is shown to exist and to be unique, after one subtraction constant for each of the functions $\alpha(t)$ and $r_{ij}(t)$, and the location of zeros of the residue functions $r_{ij}(t)$ are supplied, provided that some conditions on the subtraction constants are satisfied. (auth)

39932 FOUR NEUTRINOS. Ya. S. Smorodinskii. Priroda, No. 7, 54-6(July 1963). (In Russian)

Descriptions are given of the origin and properties of neutrinos. A four-component neutrino theory is reviewed. (R.V.J.)

39933 ELECTRON PATH LENGTH IN COLLISION EXPERIMENTS. R. K. Asundi (Univ. of Liverpool). Proc. Phys. Soc. (London), 82: 372-4(Sept. 1, 1963).

The increase in electron path length, particularly at low electron energies, evaluated on the basis of the formula given by Massey and Burhop and the consequent increase in the ionization cross section measurements reported by Tate and Smith are not borne out by the recent experiments. It is shown that the size of the electron path length is not governed by the diameter of the final aperture alone but primarily by the energy available to the electrons normal to the field direction. This analysis shows that, in agreement with experimental observations, there is negligible increase in electron path length in the Tate and Smith experiments. (auth)

39934 PION AS THE FIELD OF HEAVINESS. Takao Okabayashi (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 30: 96-102(July 1963). (In English)

It is pointed out that the composite model of the pion can easily explain the fact $g_A/g_V > 1$, where g_A and g_V are the axial-vector and the vector coupling constant of β-decay, respectively. Further, it suggests a model in which the pion plays a role to discriminate between the baryon and lepton in a symmetrical world where all quantum numbers except for baryon and lepton number degenerate. The weak coupling constant is determined by the baryon mass and the cutoff mass. A general criterion is settled that can determine whether a theory has a possibility of explaining the origin of the mass of spinor particle. (auth)

39935 NEUTRINO UNIFIED MODEL BASED ON TWO KINDS OF NEUTRINOS. Mituo Taketani and Takao Tati (Universidade, Sao Paulo, Brazil). Progr. Theoret. Phys. (Kyoto), 30: 134-6(July 1963). (In English)

Possible modifications of the neutrino unified model of elementary particles assuming the existence of two kinds of neutrinos are discussed. The hypotheses of the original neutrino unified model are replaced, and induced weak interactions and lepton and baryon currents in weak interactions are investigated. (C.E.S.)

39936 REMARKS ON THE SUPERCONDUCTOR MODELS OF ELEMENTARY PARTICLES. Mahiko Suzuki (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 30: 138-40(July 1963). (In English)

It is shown that precise equivalence holds between the energy gap in the superconductor model derived by Bardeen, Cooper, and Schrieffer and the self-consistently generated mass derived by Numbu and Jona-Lasinio only in case of four-fermion interaction. The stability criterion for the elementary particle mass equations is also derived. (C.E.S.)

39937 K* RESONANCE. Akira Kanazawa and Naoki Tokuda (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 30: 142-3(July 1963). (In English)

The self-consistency of the K* resonance is investigated. The forces are restricted to those that are produced by the exchange of the K* resonance itself and of the meson (ρ). The resonance mass, effective coupling strength, and charge radius are calculated. (C.E.S.)

39938 THEORETICALLY PREDICTED HIGHER RESONANCES. Yoneji Miyamoto (Tokyo Univ. of Education). Progr. Theoret. Phys. (Kyoto), 30: 145-7(July 1963). (In English)

Nucleon isobars and strange isobars are classified by analogy to the periodic table of atoms or nuclear shell model. The N octet family, N* 10-dimensional multiplet family, N** octet family, and Y_0^* singlet family are illustrated. Higher resonances are theoretically predicted by the classifications. Information on the mechanism of higher resonances can also be obtained. (C.E.S.)

39939 TABLES OF ELEMENTARY PARTICLES AND RESONANT STATES. Matts Roos (Nordisk Institut for Teoretisk Atomfysik, Copenhagen). Rev. Mod. Phys., 35: 314-23(Apr. 1963).

The properties of the elementary particles and also of particles customarily called resonances are set forth in tabular form. These include isospin, spin parity, strangeness, mass, magnetic moment, mean life, common decay modes, and branching ratios. The tables were made up using 60 references. (R.E.U.)

39940 ELECTRIC AND MAGNETIC FORM FACTORS OF THE NUCLEON. L. N. Hand, D. G. Miller, and Richard Wilson (Harvard Univ., Cambridge, Mass.). Rev. Mod. Phys., 35: 335-49(Apr. 1963).

The charge and magnetic form factors, $G_E(q^2)$ and $G_M(q^2)$, are discussed with emphasis on their use in electron-nucleon experiments. Electron-proton scattering and proton-antiproton annihilation are discussed with the appropriate form factors. Neutron form factors are also given. (R.E.U.)

39941 THE NUCLEON-NUCLEON INTERACTION. EXPERIMENTAL AND PHENOMENOLOGICAL ASPECTS. Richard Wilson. Interscience Tracts on Physics and Astronomy. New York, Interscience Publishers, 1963. 257p. $6.00.

The procedures involved in measuring the interaction between nucleons for comparison with theory are outlined. High and low-energy experiments and the necessary apparatus are discussed. Other topics include proton measurements, neutron measurements, theoretical interpretation, electromagnetic studies of nucleon-nucleon interactions, conservation laws, and the scattering of nucleons from light nuclei. An extensive appendix of total and differential cross sections and polarization and scattering parameters for p-p, n-n, and n-p interactions is also included. (C.E.S.)

39942 THE MANY-BODY PROBLEM. Proceedings of the Symposium held at Stevens Institute of Technology, Hoboken, New Jersey, January 28-29, 1957. Jerome K. Percus, ed. New York, Interscience Publishers, 1963. 550p. $30.00.

Multiple scattering methods and Brueckner theory for the many-body problem are considered. The energy of interacting Fermi systems, saturation of nuclear forces, and ferromagnetism of a gas of hard sphere fermions are discussed. Transitional methods, non-separable boundary value problems, low temperature properties of a Bose system of hard spheres, strong forces, collective variables without subsidiary conditions, collective methods, long-range correlations in classical and quantum systems, unified theory of interacting bosons, collective description of particle interaction, and collective coordinate methods are developed. Normal states of matter, pair correlations in liquids, effect of defects on crystal lattice vibration, and a collective approach to the dielectric constant are considered. Superfluids, coherent states in a degenerate electron gas, and boson field approach to the theory of liquid He II are discussed. Statistical mechanics and computer and Monte Carlo calculations of the many-body problem are also given. (C.E.S.)

Neutron Physics

39943 (GA-4176) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report for the Period Ending March 31, 1963. J. C. Young, J. R. Beyster, J. R. Brown, J. U. Koppel, G. K. Houghton, and G. D. Trimble (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Apr. 15, 1963. Contract AT(04-3)-167. 54p.

Existing data on angular distributions, as well as differential cross sections of water, for neutrons of various energies were compared with Nelkin's theory. Infinite medium neutron spectra in poisoned ZrH and borated polyethylene were also measured at various temperatures and compared with theoretical predictions. Similar measurements were made in borated H_2O. Infinite medium spectra in borated D_2O were also measured, and an angular flux spectrum for borated water was obtained and compared with calculations by an infinite medium diffusion theory code. The cadmium curtain experiment was repeated. The results of the measurement agree quite well with a maxwellian at 302°K between 0.01 and 0.2 ev. Albedo experiments showed lead to be a desirable wall material for the enlarged low-room-return neutron cave. Experiments also showed that the post collimator at the 16-m station does not perturb measured spectra. Experimental results on the neutron scattering law for water were compared with calculations by models that permitted and excluded the anisotropy of molecular vibrations. (D.C.W.)

39944 (HW-69871) CORRELATION OF EXPERIMENTAL ACTIVITY TRAVERSES USING FEW-GROUP NEUTRON DIFFUSION THEORY — COMPUTER PROGRAM FIT-1. J. R. Lilley (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 21, 1961. Contract AT(45-1)-1350. 24p.

A systematic method for determining the best values, in a least squares sense, for the effective diffusion parameters that will give a diffusion theory fit to experimental activity traverses is described. The generalized least-squares fitting program FIT-1, which incorporates the procedure, is also described. Theoretical flux traverses are calculated from the diffusion parameters. (D.C.W.)

39945 (NAA-SR-Memo-8742) A 23-GROUP NEUTRON THERMALIZATION CROSS SECTION LIBRARY. R. D. Doctor and M. A. Boling (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 15, 1963. Contract [AT(11-1)-Gen-8]. 175p.

A set of 23-group neutron cross sections for use in the calculation of neutron thermalization and thermal neutron spectral effects in SNAP reactors is compiled. The sources and methods used to obtain the cross sections are described. (auth)

39946 (NAA-SR-Memo-8823) MOMUS — A PROGRAM TO CONSTRUCT, UP-DATE, AND MODIFY THE NEUTRON MICROSCOPIC CROSS SECTION MASTER TAPE. NAA Program Description. R. A. Blaine (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 1963. Contract [AT(11-1)-Gen-8]. 118p.

The computer program MOMUS, which is used to construct and maintain the neutron cross section master tape containing microscopic neutron data, is described. Flow diagrams, print-outs, and data formats are included. (auth)

39947 (NARF-63-3T) A SYSTEMIZATION AND PENETRATION STUDY FOR STRAIGHT CYLINDRICAL DUCTS. D. G. Collins and L. W. McCleary (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). May 31, 1963. Contract AF33(657)-7201. 43p. (AD-417282; FZK-9-182)

A study was conducted to determine the effect that varying the length and diameter of a straight cylindrical duct

has on the neutron radiation streaming through the duct. An experiment was set up in which a polonium-beryllium source was located on centerline in the mouth of an aluminum duct penetrating a water slab. The resulting data were analyzed by use of two Monte Carlo procedures developed to analyze radiation streaming through cylindrical ducts. Results of additional calculations are shown to indicate the possibility of extending the experimental findings to duct problems involving different source energy and angular distributions and different shielding materials. (auth)

39948 (NARF-63-5T) AN ANALYSIS OF FAST-NEUTRON ENERGY-ANGLE DISTRIBUTIONS. R. E. Beissner (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Aug. 15, 1963. Contract AF33(657)-7201. 69p. (AD-416628; FZK-9-186)

The energy-angle distributions of fast neutrons transmitted through slab shields are analyzed. Comparisons of calculated and measured angle distributions show that a six-energy group, double P_2 approximation is adequate for polyethylene-slab calculations. Phenomenological arguments are presented which show that the transmitted energy-angle distribution can be described in terms of a simple asymptotic model. Suggestions for improving the asymptotic theory are included. (auth)

39949 (NP-13117) ANALYTIC EXPRESSIONS FOR CALCULATING NEUTRON DISTRIBUTION FUNCTIONS BY MONTE CARLO (thesis). Wilson Kinter Talley (California. Univ., Berkeley). [1962]. 100p.

The analytic spatial integration method for Monte Carlo is applied to more complex geometries than was previously done. Previously, the use of analytic spatial distributions provided scattering probability densities for plane source neutrons in an infinite homogeneous medium and for a plane source on the boundary of a finite slab. The solution to the more general problem of a plane source anywhere within the finite slab is presented here; however, the more complicated three-dimensional problems involving point sources are primarily treated. The scattering probability distribution functions for a point source in an infinite and a semi-infinite medium are developed, and the spatial moments of the former are given. The results for the plane source are shown to follow those from the point source. The extension of this method to finite bodies is discussed. The problem of round-off error (due to machine truncation) is examined, and a method to circumvent it is set forth. (auth)

39950 (AEC-tr-6040) EXPERIMENTAL VALUES OF MOMENTS FOR THE SLOWING-DOWN OF FISSION NEUTRONS. J. Rastoin. Translated for Oak Ridge National Lab., Tenn., from report DEP/SEPP-50. Dec. 1959. 8p.

Relations for calculating the different moments for an infinite plane source are derived using both the neutron age theory and diffusion theory. The merits and areas of validity of the two theories are discussed. Also, the slowing down in H_2O, LiH, and $C_{30}H_{62}$ of neutrons from a disk source were measured to be 30, 27, and 21.5 cm^2, respectively. The fission neutron ages for concretes and some Pb–H_2O and Fe–H_2O mixtures were found to be about 100 cm^2. (D.C.W.)

39951 (AEC-tr-6055) COMPARISON OF VARIOUS MATHEMATICAL METHODS TO CALCULATE THE SLOWING-DOWN DENSITY IN A HEAVY MEDIUM. F. Le Berre and R. Maerker (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). Translated for Oak Ridge National Lab., Tenn., from report DEP/SEPP 263/63. [nd]. 42p.

The 1/A method of calculation, and an extension of it that is valid for energies near those of the source, are developed. Calculations for graphite show that the 1/A method gives a better approximation than age theory at great distance and low energies, while the extended method gives a good approximation for energies near those of the source. Moments calculated by the 1/A method are compared with preliminary results of a Monte Carlo method. (D.C.W.)

39952 (AEC-tr-6057) TRANSPORT THEORY: P_1 APPROXIMATION AND THE BETHE-TONKS-HURWITZ METHOD. NUMERICAL RESULTS. H. G. Kaper and H. Laborde Castex (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Fontenay-aux-Roses). Translated for Oak Ridge National Lab., Tenn., from report DEP/SEPP/204bis/62. Mar. 1962. 14p.

Fluxes in a single infinite medium (carbon or sodium) from a monoenergetic source and from a fission spectrum were calculated. The response of 1/v, U^{233}, U^{235}, Pu^{239}, and perfectly resonant detectors in graphite was calculated as a neutron of distance from the source (fission neutrons). (D.C.W.)

39953 (AEC-tr-6061) PRACTICAL UTILIZATION OF THE PENELOPE PROGRAM. F. Le Berre (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). Translated for Oak Ridge National Lab., Tenn., from report DEP/SEPP/226/62. June 1962. 6p.

The calculation of fast and thermal fluxes using the Penelope program is outlined. The corrections for errors due to the calculating method are particularly emphasized. (D.C.W.)

39954 (AEC-tr-6062) APPLICATION OF THE TWO-GROUP THEORY TO THE CALCULATIONS OF GRAPHITE, BORON–GRAPHITE AND IRON MOCK-UPS IN NAIADE. M. Hot and A. Mourgues (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). Translated for Oak Ridge National Lab., Tenn., from report DEP/SEPP 205/62. Jan. 31, 1962. 25p.

The fluxes in graphite, iron, boron-graphite, and iron-boron-graphite as calculated by two-group theory with the Penelope program are compared with measurements on Naiade. (D.C.W.)

39955 (AEC-tr-6070) TRANSPORT THEORY: P_1 APPROXIMATION. H. G. Kaper (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaries, Fontenay-aux-Roses). Translated for Oak Ridge National Lab., Tenn., from report DEP-SEPP-146-61. Apr. 1961. 9p.

The hypothesis of total and elastic effective cross sections independent of theory is used to derive an expression for the neutron flux of low energy with respect to that of the source in the case of a plane symmetry in a semi-infinite medium. The fission spectrum of U^{235} is taken as the source. (auth)

39956 THE ATTENUATION OF REACTOR NEUTRONS IN POLYETHYLENE. V. N. Avaev, G. A. Vasil'ev, A. P. Veselkin, Yu. A. Egorov, Yu. V. Orlov, and Yu. V. Pankrat'ev. At. Energ. (USSR), 15: 17-20(July 1963). (In Russian)

A polyethylene block (680 × 680 × 1000 mm) made up of laminated slabs 10 and 20 mm thick was placed in a re-

search reactor beam port. The activation of indium and iodine and a BF_3 gas counter were used to detect the distribution of thermal and epithermal neutrons. The P(n,p), Al(n,p), Al(n,α) reactions, and a small ZnS(Ag) scintillation counter were used to determine the spacial distribution of fast neutrons. The theoretical neutron distribution, which was calculated by the method of moments for an isotropic point source of fission neutrons, agreed well with the experimental distribution of neutrons found by the Al(n,p), Al(n,α), and P(n,p) reactions. The relation lengths of neutrons having energies of $E_n > 74.7$ and $E_n > 2.8$ Mev are 12 to 17%. An equilibrium neutron spectrum for thermal, epithermal, and fast neutrons is established at a polyethylene thickness of 20 to 30 g/cm^2. (TTT)

39957 THE SPECTRA OF FAST REACTOR NEUTRONS PASSING THROUGH POLYETHYLENE. V. N. Avaev, G. A. Vasil'ev, A. P. Veselkin, Yu. A. Egorov, Yu. V. Orlov, and Yu. V. Pankrat'ev. At. Energ. (USSR), 15: 20-2(July 1963). (In Russian)

Squares of polyethylene 680 × 680 × 10 mm thick were installed in one of the ports of a water-cooled reactor. The fast neutron energy spectrum was obtained by determining the amplitude of recoil protons produced in a stilbene crystal 30 mm in diameter and 20 mm high. A layer of lead 16 cm thick was used in front of the polyethylene in order to reduce the γ background. The polyethylene contained 0.5 wt. % boron to reduce the thermal neutron flux. In addition, a layer of bismuth 5 cm thick covered the stilbene crystal. The fast neutron flux from energies of 1 to 10 Mev is given for polyethylene thicknesses of 10, 20, 30, 60, and 80 g/cm^2. The reactor power was varied by a factor of 10^4 depending on the thickness of the polyethylene layer in taking the measurements. The measured results agree with the calculated values, which were obtained by using the method of moments, at neutron energies of $E_n > 3$ Mev. The drop in neutron energy is greater than the calculated value at $E_n < 3$ Mev. (TTT)

39958 AN EXPERIMENTAL SET-UP FOR STUDYING THE POLARIZATION OF FAST NEUTRONS. N. V. Alekseev, U. R. Arifkhanov, N. A. Vlasov, V. V. Davydov, and L. N. Samoilov. At. Energ. (USSR), 15: 62-4(July 1963). (In Russian)

The polarization of neutrons obtained from the T(p,n)He^3 reaction was determined by scattering on He^4 at an angle of 123°. A spherical or cylindrical chamber with a glass window on one side was filled to a pressure of 100 atm with He^4 containing 3 to 5% xenon. The scattered neutrons were counted on a scintillation counter consisting of an activated polystyrene cylinder 70 × 100 mm and a FEU-36 photomultiplier. Light pulses from the helium chamber were also counted with a FEU-36 photomultiplier. The helium chamber and the neutron counter were connected in a fast-slow coincidence scheme in order to distinguish the (n,α) scattering events from other phonons and to measure the spectrum of the recoil α particles. A water-cooled solenoid consisting of a 1000 turns and made in 50 sections was placed between the tritium target and the helium chamber in order to change the neutron spin by 90°. With an incident proton energy of $E_p = 10.5$ Mev, the polarization of neutrons from the T(p,n)He^3 reaction was measured at an angle of 40° in the laboratory system of coordinates. The average asymmetry A_0 was (27.4 ± 3.9)%. The polarization P was equal to (−28.6 ± 4.1)% at an angle of 40°. This method will be used to measure the polarization of 5- to 40-Mev neutrons. (TTT)

39959 THE RATIO OF THE THERMAL NEUTRON FLUX IN WATER TO THE STRENGTH OF A POINT SOURCE. E. A. Garusov and Yu. V. Petrov. At. Energ. (USSR), 15: 71(July 1963). (In Russian)

Experimental data are available on the distribution of 1.46-ev neutrons in water around a point source of fissioning U^{235}. The diffusion length for thermal neutrons was assumed to be 2.73 cm, and the diffusion coefficient was taken to be 0.165 cm. The ratio of the thermal neutron flux to source strength ϕ_t/W was calculated to be 38 × 10^{13} by the age approximation, 100 × 10^{13} from the theory of three groups, and 80 ± 20 × 10^{13} as determined experimentally. Aging of the neutron to thermal energies was assumed to be 28.3 cm^2. It is pointed out that the age approximation is not applicable to ordinary water. (TTT)

39960 AN APPROXIMATE RELATION BETWEEN KINETIC AND ACTIVATION NEUTRON TEMPERATURES. F. Palazzi (Laboratori CISE, Milan). Energia Nucl. (Milan), 10: 375-80(July 1963). (In English)

A relation between kinetic and activation neutron temperatures was deduced. Such a relation may be obtained only in an approximate way, if the very neutron density is unknown. Since through an experimental measurement the activation temperature is obtained, with such a method the wanted kinetic temperature can be calculated. (auth)

39961 ORTHOGONAL POLYNOMIAL ANGULAR EXPANSION OF THE BOLTZMANN EQUATION. G. C. Pomraning and M. Clark, Jr. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng., 17: 8-17(Sept. 1963).

The angular dependence of the solution of the monoenergetic Boltzmann equation in slab geometry with isotropic scattering is expanded classically in the set of Jacobi polynomials, which are orthogonal in the interval −1 to +1 with respect to the weight function $w(\mu) = (1-\mu)^{\alpha} \cdot (1+\mu)^{\beta}$. The low order solution obtained by retaining only the first two terms in the expansion is investigated in detail. In this low order it is shown that a proper choice of α and β leads to the exact asymptotic transport eigenvalue. With this choice of α and β, a significant improvement in the linear extrapolation distance and the critical size of a bare slab over the usual (P − 1) diffusion theory is obtained. However, it is shown that, in general, the truncated set of classical Jacobi equations does not conserve neutrons. A modification in the truncation procedure is made in order to obtain neutron conservation while retaining the advantages of the Jacobi expansion. The choices $\alpha = \beta = -\frac{1}{2}$ and $\alpha = \beta = -1$ are discussed in some detail and shown to have advantages over the corresponding Legendre ($\alpha = \beta = 0$) expansion. (auth)

39962 PROPAGATION OF NEUTRON WAVES IN MODERATING MEDIA. R. B. Perez and R. E. Uhrig (Univ. of Florida, Gainesville). Nucl. Sci. Eng., 17: 90-100(Sept. 1963).

Use of a sinusoidally modulated source of neutrons is equivalent to poisoning a moderating medium with a 1/v poison. The inverse relaxation length of the neutron wave amplitude and the variation of the phase angle as a function of position are dependent upon the frequency of modulation and the neutron diffusion and thermalization parameters of the media in which the waves are being propagated. The neutron wave technique allows poisoning of solid moderators and provides a means of performing poisoning experiments for measuring nuclear properties of solid as well as liquid moderators. It should supplement the recent use of poisoning techniques in an attempt to reconcile discrepancy in the diffusion and thermalization parameters of moderators, as measured by pulsed neutron techniques. The neutron wave technique and the pulsed

neutron technique are supplementary from an experimental viewpoint. (auth)

39963 ON THE MASS TENSOR APPROXIMATION OF SLOW NEUTRON SCATTERING. G. Kosláy and G. Solt (Central Research Inst. of Physics, Budapest). Phys. Letters, 6: 51-2(Aug. 15, 1963). (In English)

The mass tensor approximation for determining the cross section for slow neutron scattering in molecular gases is discussed analytically. The case of a symmetrical dumb-bell molecule is considered. It is shown that the mass tensor approximation is a large-recoil, high temperature approximation analogous to the large-recoil approximation for scattering in crystals. (C.E.S.)

39964 MEDLENNYE NEITRONY. (Slow Neutrons). V. F. Turchin. Moscow, Gosatomizdat, 1963. 372p.

A systematic account is given on problems of inelastic scattering of slow neutrons. The first part of the book deals with production and detection of neutrons, the theory of slow neutron interactions with materials, coherent elastic scattering, spectrometry, measurement of scattering cross sections, slow neutron scattering in crystals, gases, and fluids, and neutron magnetic scattering. The second part on thermalization and neutron diffusion deals with kinetic equations and stationary and non-stationary neutrons. 158 references are included. (R.V.J.)

Nuclear Properties and Reactions

Refer also to abstracts 38588, 38593, 38606, 38619, 38621, and 39308.

39965 (BLG-173) APPORTS RECENTS DE LA PHYSIQUE DES IONS LOURDS A LA PHYSIQUE NUCLEAIRE. (Recent Contributions to the Physics of Heavy-Ions in Nuclear Physics). M. Demeur (Brussels. Université and Mol, Belgium. Centre d'Etude de l'Energie Nucléaire). Apr. 1963. 14p. (CONF-210-1)

From Conference on Nuclear Physics, Orsay, France, May 1963.

Recent research on the reaction mechanisms between heavy ions is briefly surveyed. The new possibilities offered by the observation of higher-order effects in Coulomb excitation and the description of quasi-molecular states by a new individual particle model are emphasized. (auth)

39966 (BNL-818) OPTICAL MODEL ANALYSIS OF INELASTIC SCATTERING OF NEUTRONS BY HEAVY NUCLEI. S. O. Moore and E. H. Auerbach (Brookhaven National Lab., Upton, N. Y.). Aug. 1963. Contract [AT(30-2)-Gen-16]. 46p. (BNL-T-317)

A spherical optical potential was used to calculate the neutron scattering cross sections of Ta^{181}, W^{184}, Au^{197}, Pb^{208}, Bi^{209}, Th^{232}, and U^{238}. The parameters were determined by fitting the differential and total elastic cross section data. The calculated differential (at various energies) and total elastic cross sections are compared with experimental data, as are the calculated inelastic and differential inelastic cross sections for the excitation of various energy levels. Calculated total elastic angular distributions and the level schemes, parameters, and data sources used are also included. (D.C.W.)

39967 (BNL-6780) PARAMETERS OF THE 132-eV NEUTRON RESONANCE IN Co^{59}. A. P. Jain, R. E. Chrien, J. A. Moore, and H. Palevsky (Brookhaven National Lab., Upton, N. Y.). Jan. 18, 1963. Contract AT-30-2-GEN-16. 22p.

The parameters of the resonance excited by the interaction of 132-ev neutrons with a Co^{59} target nucleus were accurately determined, using fast choppers. Neutron transmission through thick and thin samples resulted in the following parameters: $E_r = 132.0 \pm 0.5$ ev; $2g\Gamma_n = 5.77 \pm 0.07$ ev; $\Gamma = 5.35 \pm 0.10$ ev; and $J = 4$. In addition, measurements of the resonance capture γ-ray intensity gave the value for the radiation width $\Gamma_\gamma = 0.40 \pm 0.04$ ev, based on the known thermal capture cross section of cobalt of 37.5 barns. The reduced and total resonance capture integrals are calculated from the above parameters to be 50.5 ± 5.5 and 67.0 ± 5.5 barns, respectively. The above results are compared with previously determined resonance parameters and also with direct measurements of the total resonance capture integral. (auth)

39968 (BNL-7234) MEASUREMENTS OF NEUTRON RESONANCE PARAMETERS. R. E. Chrien (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract [AT(30-2)-Gen-16]. 29p. (CONF-218-1)

From Symposium on Statistical Properties of Atomic and Nuclear Spectra, Stony Brook, N. Y., May 1963.

The time-of-flight apparatus and experiments used to obtain resonance parameters and average resonance properties are surveyed. Some results and some information on data analysis are also included. (D.C.W.)

39969 (BNL-7333) THE PRESENT EXPERIMENTAL AND THEORETICAL STATUS OF THE PROBLEM OF ELECTRON EJECTION IN THE ALPHA DECAY OF Po^{210}. William Rubinson (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 11p. (CONF-233-1)

From Conference on the Role of Atomic Electrons in Nuclear Transformations, Warsaw, Sept. 1963.

The experimental measurements of electron ejection in Po^{210} decay are discussed, and the theory of the process is outlined. The order-of-magnitude discrepancy between theory and experiment that was evident a decade ago has not yet been definitively resolved. The discrepancy is ascribed to an inadequacy of the theory, in particular to the use of an asymptotic expansion in that theory. Brief mention is made of some very recent unpublished calculations by G. W. Schaefer in which a reasonable estimate of the K-ejection probability is obtained by a procedure that avoids the asymptotic expansion. (auth)

39970 (EANDC-28(L)) TECHNICAL MINUTES OF THE FIFTH MEETING OF THE COMMITTEE, FEBRUARY 4–8, 1963, A.E.C.L. CHALK RIVER, CANADA. R. Batchelor, comp. (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England and European-American Nuclear Data Committee). July 1963. 47p.

Minutes are presented for the fifth meeting of the European-American Nuclear Data Committee. The following items are discussed: program and facility status reports, research activities, discrepancies in neutron cross sections, measurements on fissile and other nuclei, target and foil preparation, and standards. Lists are given of documents which were submitted at the meeting, and several letters are reprinted. (D.L.C.)

39971 (EANDC(E)-47(L)) COMPILATION OF REQUESTS FOR NUCLEAR CROSS SECTION MEASUREMENTS FROM EURATOM COUNTRIES. J. Spaepen (European-American Nuclear Data Committee). July 1963. 29p.

Some requests from Euratom countries for neutron cross section data are compiled in order of priority. (D.C.W.)

39972 (EIR-52) PROPOSAL FOR THE MEASUREMENT OF TOTAL DIFFERENTIAL CROSS SECTIONS OF RADIOACTIVE Rh^{105}, Pm^{148m} AND Pm^{148}. G. D. Hickman (Switzerland. Eidgenössisches Institut für Reaktorforschung, Würenlingen). June 1963. 29p.

Calculations have shown that a sample of Rh^{105} could be produced in a flux of 3×10^{13} n/cm^2/sec which could be used for a cross section measurement. The relative abundance of Rh in the activated sample must be increased through a chemical separation between Ru and Rh. Possible interference to the cross section measurement could arise from the production of Ru^{97} and Ru^{103}. It is shown that where a sample of Pm^{148m} could also be produced in this flux for similar measurements, a much higher flux would be required to produce a good sample of Pm^{148}. The activity of these samples is less than 1000 Curies and should not present any extreme handling difficulties. (auth)

39973 (EUR-205.f) COURANT A TRAVERS LA SURFACE LATÉRALE D'UN CYLINDRE UNIFORMÉMENT ÉMETTEUR ET AUTO-ABSORBANT. (Current Across the Lateral Surface of a Uniformly Emitting and Self-Absorbent Cylinder). U. Canali, R. Nicks, and C. Pleinevaux (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 38p.

The expression for the particle current crossing the boundary of an infinite circular cylinder was obtained as a rapidly converging series and was evaluated as a function of the linear absorption coefficient. The error made by substituting the cylinder current by the current at the center of a hemisphere whose radius equals the diameter of the cylinder, never exceeds 6%. As an approximation for the finite cylinder, the intersection of the cylinder by a spheric surface has been considered. The current due to this solid was evaluated, as well as the upper limits for the errors made. (auth)

39974 (INSJ-59) PARTIAL EQUILIBRIUM MODEL FOR NUCLEAR REACTIONS. [PART] I. Ko Izumo (Tokyo Univ. Inst. for Nuclear Study). Sept. 3, 1963. 25p.

The excited nuclei forming intermediate resonances are classified into three groups characterized by the excitation of five, six, or seven outer nucleons, respectively. It is pointed out by numerical calculations of angular distributions in the reactions $Ni^{58}(p,p')Ni^{58*}$, $Ni^{58}(p,\alpha)Co^{55}$, and $Ni^{60}(p,p')Ni^{60*}$ that when the reactions belong to the same group the same intermediate resonance appears at the corresponding resonance energies even if their compound nuclei are different. The fine structures of intermediate resonances are also studied. (auth)

39975 (LAMS-2941) LOS ALAMOS GROUP-AVERAGED CROSS SECTIONS. Lucie D. Connolly (Los Alamos Scientific Lab., N. Mex.). July 1963. Contract W-7405-eng-36. 105p.

Group constants and computed neutron cross sections are tabulated for various reactor materials. These are presented as 6-, 16-, 18-, 24-, and 25-group calculations for reactors with neutron energies ranging from fast to thermal. (auth)

39976 (NARF-62-17T) NEUTRON CROSS SECTIONS FOR NITROGEN AND OXYGEN. R. L. Kloster and M. B. Wells (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). May 31, 1963. Contract AF33(657)-7201. 97p. (AD-417704; MR-N-298)

Cross sections for the following processes are compiled for both oxygen and nitrogen: total, elastic scattering, nonelastic collisions, inelastic scattering, differential elastic scattering, (n,α), (n,p), and (n,d). The following cross sections are included for nitrogen only: gamma-ray production, (n,t), (n,2n), and (n,2α). Cross sections of nitrogen for excitation of the various levels of the residual nucleus in the (n,αj), and (n,n'j) are also compiled. 63 references. (auth)

39977 (NP-13113) EXPERIMENTAL STUDY OF He^3 PHOTODISINTEGRATION. Technical Report No. 45. Barry L. Berman, Louis J. Koester, Jr., and J. H. Smith (Illinois. Univ., Urbana). July 1963. Contract ONR 1834(05). 123p.

The 90° photodisintegration cross sections for He^3 were measured for incident photon energies between 8.5 and 21.5 Mev by detecting proton-deuteron coincidences in CsI(Tl) scintillators immersed in 1 atm of gas. The peak cross section for the $He^3(\gamma,p)d$ reaction, which is very sensitive to the nuclear size, occurs at 10.8 ± 0.3 Mev and equals 0.092 ± 0.004 mb/ster. Gaussian ground state wave functions for He^3 fail to predict the shape of the cross section curve. The modified exponential wave function of Gunn and Irving gives a good fit for a root-mean-square nuclear radius of 1.94 F (corresponding to a charge radius of 2.1 F). The He^3 charge form factor calculated with this wave function agrees very well with the electron scattering measurements of Collard and Hofstadter for small momentum transfers q and deviates by 20% only at $q^2 = 5\ F^{-2}$. Also, some information was acquired about the competing three-body photodisintegration process by detecting p-p coincidences in the case where the angle between the two outgoing protons was near either 90° or 180°. 48 references. (auth)

39978 (NP-13134) DETERMINATION OF THE CAPTURE CROSS SECTION OF GRAPHITE BY THE PILE OSCILLATOR METHOD. Al. Stefănescu, I. Iftode, M. Sabău, and C. Tapu (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). Apr. 1963. 12p.

The results of the measurements of the capture cross section of a graphite made by the pile oscillator method are presented. With the electronic system used, the difference in the capture cross section of two qualities of graphite can be determined with an error on the order of 11%. (auth)

39979 (NYO-9539) THE $He^3(d,p)He^4$ AND $He^3(d,d)He^3$ REACTIONS AT 23.2 TO 27.0 Mev. O. M. Bilaniuk and R. J. Slobodrian (Argentina. Comision Nacional de Energia Atomica, Buenos Aires). Aug. 14, 1963. Contract AT(30-1)-875. 23p.

Angular distributions and absolute cross sections were measured for the $He^3(d,p)He^4$ reaction at bombarding energies of 23.2, 24.0, 24.7, 25.5, 26.2, and 27.0 Mev in the angular range from 0 up to 170° (c.m.) Both the shapes and the absolute values of the cross sections show no change in this entire energy range, except for variations which fall within the experimental uncertainty of 7% for the relative, and of 15% for the absolute values. The $He^3(d,p)He^4$ angular distributions exhibit pronounced features of a direct reaction, but cannot be fitted with conventional PWBA functions. However, a good fit is obtained for all six distributions using the square of the cylindrical Bessel function of zeroth order with momentum transfer as argument. The role of interaction potentials, as derived from angular distributions, is discussed. The angular distributions of deuterons elastically scattered from He^3 were recorded in the angular range from 16 up to 102° (c.m.) at the six energies indicated above. Again, all six experimental curves fall within statistics of one another. (auth)

39980 (ORNL-TM-666) REACTOR-PRODUCED RADIOISOTOPES. [PART] I. T. A. Butler, R. E. Lewis, J. J. Pinajian, and J. E. Ratledge (Oak Ridge National Lab., Tenn.). Oct. 15, 1963. Contract W-7405-eng-26. 24p.

A description of the Oak Ridge Research Reactor (ORR), its operating characteristics, and the facilities available to the Isotopes Development Center is presented. The production of Ir^{192}, the effect of Ir^{191} loading on the normal flux (flux perturbation), and the flux depression within the sample of Ir^{191} were determined. The "effective flux" under optimum conditions of loading was determined to be 15% of the unperturbed flux (1.84×10^{11} neutrons cm^{-2} sec^{-1}). Fast neutron utilization in the ORR [viz., (n,p) reactions] is described, and the reaction energetics are examined. The experimental and estimated yields of $Zn^{67}(n,p)Cu^{67}$ and $Fe^{54}(n,p)Mn^{54}$ reactions are found to be in a ratio of 3.2 and 0.85, respectively. (auth)

39981 (UCRL-10516) NEUTRON ENERGY SPECTRA FROM NUCLEI EXCITED BY μ^--MESON CAPTURE (thesis). Donald E. Hagge (California. Univ., Berkeley. Lawrence Radiation Lab.). June 12, 1963. Contract W-7405-eng-48. 81p.

The neutron energy spectra from nuclear capture of μ^- mesons in Al, Ca, Fe, Ag, I, Au, and Pb were measured. Nuclear temperatures were deduced from the spectra according to the Weisskopf evaporation theory. Results were compared to other experimental measurements and consistency with compound nuclear theory was discussed. The direct neutron emission spectrum was calculated by using a degenerate Fermi gas model and momentum distributions of a Gaussian type. The neutron detector was a liquid scintillation counter in conjunction with a pulse-shape discrimination circuit used for γ-ray rejection. The recoil-proton pulse-height spectra were unfolded by a computer code to obtain the neutron energy spectra. Measurements of neutrons from deuterium-tritium and Be–Pu sources indicate good reproduction of spectra if single collisions with hydrogen are assumed. 47 references. (auth)

39982 (NP-13139) BIBLIOGRAPHY OF PHOTO- AND ELECTRONUCLEAR DISINTEGRATIONS. Bibliography No. 22. Revision of Bibliography No. 18. M. Elaine Toms, comp. (Naval Research Lab., Washington, D. C.). July 1963. 152p.

Fifteen hundred and eight references to articles on experimental and theoretical results for photodisintegration, photoproduction, photofission, photon absorption, and photon sources are compiled. An author index is included. (D.C.W.)

39983 (TID-19406) A STUDY OF THE DECAY OF Tm^{168} TO LEVELS IN Er^{168} USING COINCIDENCE AND DIRECTIONAL CORRELATION TECHNIQUES. J. J. Reidy, E. G. Funk, and J. W. Mihelich (University of Notre Dame, Notre Dame, Ind.). [1962]. Contract [AT(11-1)-498]. 48p.

The levels in Er^{168} populated by electron capture of Tm^{168} were studied using scintillation spectrometers, gamma-gamma and electron-gamma coincidence measurements, and directional correlation techniques. The following conclusions were reached: the spin and parity of the 1543-kev level are 3-; the 1280-kev transition is E1(<0.08% M2); the 721-kev transition is E1(<0.05% M2); and the 743-kev transition is E2(<2.4% M1). The attenuation coefficient G_2 for the 1280 kev-80 kev correlation was determined to be 0.77 ± 0.19 for a source consisting of a dilute aqueous solution of $TmCl_3$. The analysis of the results of the Tm^{168} decay is compared with the predictions using various models. The ratios of reduced transition probabilities for transitions from the gamma vibrational band in Er^{168} are analyzed and a band-mixing parameter $z = 0.055$ is found. (auth)

39984 (UCRL-7229) $N^{15}(p,n)O^{15}$ GROUND STATE REACTIONS AND THE QUASI-ELASTIC MODEL OF (p,n) REACTIONS. Luisa F. Hansen and Marion L. Stelts (California. Univ., Livermore. Lawrence Radiation Lab.). May 15, 1963. Contract W-7405-eng-48. 33p. (CONF-46-97)

From American Physical Society 1963 Spring Meeting, Washington, D. C., Apr. 1963.

The $N^{15}(p,n)O^{15}$ reaction was studied from 3.95 to 9.0 Mev using a long counter. Absolute cross sections and angular distributions were measured from 0 to 170° in 10° steps. The angular distributions were analyzed using the optical model potential suggested by Lane which is a function of the isotopic spins of the incident proton and target nucleus. Calculations were made using a distorted-wave Born approximation and also, for the higher energies, optical model analysis. The results of these two methods are compared. The excitation function shows broad resonances at 4.30, 5.50, 6.50, 7.65, and 8.99 Mev. With the exception of the resonance at 4.30 Mev, all the others can be interpreted as due to single particle resonances. A tentative assignment of l and J values is given. (auth)

39985 (USNRDL-TR-633) ESTIMATED TOTAL CHAIN AND INDEPENDENT FISSION YIELDS FOR SEVERAL NEUTRON-INDUCED FISSION PROCESSES. L. E. Weaver, P. O. Strom, and P. A. Killeen (Naval Radiological Defense Lab., San Francisco). Mar. 5, 1963. Contract AT(49-7)-1963. 41p.

Calculated estimates are presented of unmeasured total chain yields and of independent fission yields for the fission products resulting from fission-spectrum and 14-Mev neutron bombardment of U^{233}, U^{235}, U^{238}, and Pu^{239} and from thermal neutron bombardment of U^{233}, U^{235}, and Pu^{239}. (auth)

39986 A THEORY OF FLUCTUATIONS IN NUCLEAR CROSS SECTIONS. Torleif Ericson (CERN, Geneva). Ann. Phys. (N. Y.), 23: 390-414(Sept. 1963).

A quantitative description of the statistical fluctuations in the region of overlapping resonances of nuclear cross sections is given. General nuclear reaction theory is used in order to systematically obtain a separation of direct interactions and compound nuclear contributions in the region of overlapping resonances. (R.E.U.)

39987 THE NUCLEAR MANY-BODY PROBLEM USING THE BOUNDARY CONDITION MODEL. Earle L. Lomon (Massachusetts Inst. of Tech., Cambridge) and Malcolm McMillan. Ann. Phys. (N. Y.), 23: 439-68(Sept. 1963).

The nuclear many-body problem is discussed in terms of the boundary-condition model (BCM). For simplification of the problem, the BCM is formulated in terms of a potential (or pseudopotential). The two-body scattering problem is discussed in order to illustrate the use of this pseudopotential. Methods are introduced to handle the center-of-mass momentum dependence of the nuclear matter K-matrix for interactions in general and interactions in $^1S_0$ states only. (R.E.U.)

39988 THE KINETIC ENERGY OF THE FISSION FRAGMENTS AND THE LONG-RANGE α-PARTICLES IN THE TERNARY FISSION OF U^{235}. V. N. Dmitriev, K. A. Petrzhak, and Yu. F. Romanov. At. Energ. (USSR), 15: 6-11(July 1963). (In Russian)

Groups of α particles having average energies of 10.6, 16.4, 20.3, and 24.0 Mev from the ternary fission of U^{235} were counted by using different thicknesses of aluminum foil. The relative number of ternary fission events to binary fission events is tabulated for the four groups of α-particle energies. The energies of the fission fragments from ternary fission were measured by a multi-channel amplitude analyzer. The total decreases in energy of the light and heavy fission fragments ΔE_l and ΔE_h are tabulated for the four groups of α-particle energies. The total decrease in energy of the fission fragments (ΔE_t) is 10.9 Mev for an average E_α of 10.6 Mev, 15.0 Mev for an E_α of 16.4 Mev, 14.8 Mev for an E_α of 20.3 Mev, and 15.5 ± 1.6 Mev for an E_α of 24.0 Mev. The results show that the total kinetic energy during ternary fission increases with increasing energy of the long-range α particle and can significantly exceed the total kinetic energy of binary fission. The mass ratio of the fission fragments (M_2/M_1) remains constant at 1.5 for various energies of the long-range α particles. (TTT)

39989 THE NUMBER OF PROMPT NEUTRONS AND THE KINETIC ENERGY OF FISSION FRAGMENTS FROM THE LOW-ENERGY FISSION OF U^{235}. Yu. A. Blyumkina, I. I. Bondarenko, V. F. Kuznetsov, V. G. Nesterov, V. N. Okolovich, and G. N. Smirenkin. At. Energ. (USSR), 15: 64-6(July 1963). (In Russian)

At high neutron energies (E_n), the average kinetic energy $\overline{E}_k$ of the fission fragment is independent of the excitation energy of the fissioning nucleus, and a linear increase in the average number of prompt neutrons $\overline{\nu}$ can be observed with increasing neutron energy E_n. Values of $\overline{\nu}$ and $\overline{E}_k$ were measured at low neutron energies (E_n) in order to detect possible effects associated with the discrete spectrum obtained by fission with s- and p-neutrons. Values of $\overline{\nu}(E_n)$ were determined for E_n = 0 to 1.0 Mev, and values of $\overline{E}_k(E_n)$ were determined for E_n = 0 to 2.5 Mev. The results can be represented by the equation $E_n = \Delta\overline{E}_k + a\Delta\overline{\nu}$, where a is the reciprocal of the term $d\overline{\nu}/dE_n \equiv 0.13$ Mev^{-1}, which characterizes the linear increase in ν with increasing E_n at high excitation energies. Calculated values of $\overline{\nu}' = \overline{\nu}_t + (d\nu/dE_n)(E_n - \Delta\overline{E}_k)$ are compared with directly measured values of $\overline{\nu}$ for values of E_n = 0 to 1.5 Mev. The experimental results show that at low neutron energies (E_n < 0.5 Mev), there is a difference in the kinetic energies of the fission fragments and a difference in $\overline{\nu}$ during fission by s- and p-neutrons. (TTT)

39990 NUCLEAR REACTIONS INDUCED IN TANTALUM BY PROTONS OF ENERGY UP TO 84 Mev. C. L. Rao and L. Yaffe (McGill Univ., Montreal). Can. J. Chem., 41: 2516-32(Oct. 1963).

Nuclear reactions induced in tantalum by protons of energy up to 84 Mev were studied and excitation functions obtained for products formed by (p,xn), (p,pxn), (p,2pxn), and (p,3pxn) reactions. Radiation characteristics of the products were redetermined. Previously unreported γ rays with energies 90 to 1050 kev were found for W^{176}, and 113 kev for W^{177}. A new half life of 2.7 ± 0.1 hr for W^{176} is reported. The cross sections for the (p,xn) reactions were compared with the values previously predicted by a schematic model and found to be in reasonable agreement. More complex reactions are discussed in the light of current nuclear theories. (auth)

39991 THE SPALLATION OF IRIDIUM WITH PROTONS OF ENERGIES 9-87 Mev. G. R. Grant and L. Yaffe (McGill Univ., Montreal). Can. J. Chem., 41: 2533-43(Oct. 1963).

Iridium metal was bombarded with protons varying in energy from 8 to 87 Mev. The spallation products were radiochemically separated and decay characteristics and formation cross sections were determined. It was confirmed that both Pt^{187} and Pt^{188} have half lives of about 3 hr, and a half-life of 13.3 ± 0.2 days was found for Ir^{189}. An isomeric state of Ir^{188} with half life 2.0 ± 0.5 hr was found. Fair agreement was obtained between excitation functions for (p,xn) reactions determined experimentally and those predicted by the Jackson model. The (p,pn) yield at 84 Mev was compared with that calculated from Monte Carlo cascade data combined with evaporation theory and found to be too high by a factor of 4. (auth)

39992 REACTIONS PRODUCED ON ERBIUM BY PROTONS OF ENERGIES BETWEEN 6 AND 87 Mev. G. V. S. Rayudu and L. Yaffe (McGill Univ., Montreal). Can. J. Chem., 41: 2544-56(Oct. 1963).

Erbium was bombarded with protons of energies varying between 6 and 87 Mev. Nuclear characteristics and excitation functions were studied for isotopes of Tm, Er, Ho, and Dy, formed by various (p,xn) and (p,xpxn) reactions. Bombardment of enriched Er isotopes helped elucidate some of the excitation functions. A comparison was made of the experimental (p,xn) cross sections with those predicted by the Jackson model and reasonable agreement was found. Holmium was bombarded with α-particles to produce the compound nucleus Tm^{169*} and the ratios $\sigma(p,n)$: $\sigma(p,2n)$ = $\sigma(\alpha,n)$: $\sigma(\alpha,2n)$ were found to hold. (auth)

39993 NUCLEAR ISOMERS $Hg^{197m,g}$, $Hg^{195m,g}$, AND $Au^{196m,g}$ FORMED BY BOMBARDMENT OF GOLD WITH PROTONS OF ENERGIES FROM 8 TO 60 Mev. R. S. Tilbury and L. Yaffe (McGill Univ., Montreal). Can. J. Chem., 41: 2634-41(Oct. 1963).

Gold was bombarded with protons of energies from 8 to 60 Mev to study excitation functions and isomer yield ratios for the formation of the isomeric pairs $Hg^{197m,g}$, $Hg^{195m,g}$, and $Au^{196m,g}$. For $Hg^{197m,g}$ and $Hg^{195m,g}$, the ratio of the yield of the metastable state to that of the ground state, σ_m/σ_g, was found to increase with increasing proton bombarding energy up to 20 and 35 Mev, respectively, while that for $Au^{196m,g}$ showed a maximum at about 40 Mev. (auth)

39994 STUDY OF (n,α) REACTIONS ON EVEN-EVEN NUCLEI WITH THE AID OF A DIRECT INTERACTION PROCESS. Jean-Noel Massot, Edgard El-Baz, and Joseph Lafoucriere. Compt. Rend., 257: 879-82(July 22, 1963). (In French)

The angular distributions of X(n,α)Z reactions were theoretically calculated by mixture of two direct interaction processes: capture (pick-up) of He^3 or projection (knock-out) of He^4. A numerical application is made to $O^{16}(n,\alpha)C^{13}$ at 6 and 8 Mev. (tr-auth)

39995 CONVERSION ELECTRON SPECTRUM ASSOCIATED WITH THE TRANSMUTATION OF RADIUM-226 INTO RADON-222. Maria Teresa Goncalves. Compt. Rend., 257: 887-90(July 22, 1963). (In French)

The conversion electron spectrum emitted during the $Ra^{226} \xrightarrow{\alpha} Rn^{222}$ transmutation was studied by the nuclear plate method. The internal conversion coefficients of the 187-kev radiation were determined, and the following values were obtained: $\alpha_K = 0.22 \pm 0.02$, $\alpha_L = 0.29 \pm 0.02$, $\alpha_{M+N\ldots} = 0.12 \pm 0.01$, and $\alpha_{total} = 0.64 \pm 0.05$. (tr-auth)

39996 NOTE ON 5^- LEVELS IN EVEN-EVEN NUCLEI. M. K. Ramaswamy (Karnatak Univ., Dharwar-3, India). Current Sci. (India), 32: 63-4(Feb. 1963).

An examination of available data on the 5^- levels of even-

even nuclei reveals that: the excitation energy of these levels varies very little with mass number, suggesting some sort of core excitation; no 5^- level is definitely known for A < 90; if the proposed vibrational description of the 5 states is correct, inelastic electron scattering should excite them. (D.C.W.)

39997 LIFETIME OF THE 70-Kev LEVEL IN Sb^{121}. M. K. Ramaswamy (Karnatak Univ., Dharwar-3, India). Current Sci. (India), 32: 107(Mar. 1963).

Delayed coincidence measurements gave a value of 8 ± 1.5 nsec for the lifetime of the 70-kev Sb^{121} level. Gupta's proposed ordering of the Sb^{121} levels (70, 576, and 1200 kev) was confirmed. The lifetime of the 576-kev level was determined to be <1 nsec. If the 70-kev transition is pure M1, the measured lifetime gives a retardation factor of about 360. (D.C.W.)

39998 LIFETIME STUDIES IN TELLURIUM-121. M. K. Ramaswamy (Karnatak Univ., Dharwar-3, India). Current Sci. (India), 32: 159(Apr. 1963).

An upper limit of 1 nsec was established for the lifetime of the 214-kev level of Te^{121} by delayed-coincidence measurements. This lifetime gives an upper limit of 400 for the M1 retardation factor, not small enough to exclude the l-forbidden assignment for the transition from this level. (D.C.W.)

39999 REVIEW OF RECENT RESULTS ON INTERNAL CONVERSION. M. K. Ramaswamy (Karnatak Univ., Dharwar-3, India). Current Sci. (India), 32: 249-51(June 1963).

Some improvements in internal conversion theory and conversion coefficient measurement techniques are described. The agreement of recent data with theory is also examined. General agreement is noted when finite size effects are taken into account. (D.C.W.)

40000 L-FORBIDDEN TRANSITIONS NEAR DEFORMED REGION. S. M. Brahmavar and M. K. Ramaswamy (Karnatak Univ., Dharwar, India). Current Sci. (India), 32: 254(June 1963).

An analysis of the available data shows that as the neutron number approaches 90, which characterizes the onset of nuclear deformation, the M1 retardation factors decrease. Incomplete data permitted no observations on trends in E2 enhancement and the surface tension parameter. (D.C.W.)

40001 INVESTIGATION OF $Dy^{155} \rightarrow Tb^{155}$ DECAY. J. Urbanec, J. Kajfosz, J. Zvolsky, and A. Novgorodov. Czech. J. Phys., 13: 573-8(1963). (In Russian)

The gamma spectrum and coincidences of gamma rays appearing in $Dy^{155} \rightarrow Tb^{155}$ decay were measured with the aid of a scintillation gamma spectrometer. The Dy^{155} source was obtained by a repeated chromatographic separation from Ho fraction produced by a spalation reaction Ta + p(E_p = 660 Mev). Dy^{155} appears as a decay product of Ho^{155}($T_{1/2}$ = 45 min). In the gamma spectrum new transitions in the energy range 1170 to 2000 kev were observed. As a result of $\gamma-\gamma$ coincidence measurements, a new energy level (1820 ± 15 kev) of Tb^{155} is obtained. (auth)

40002 NUCLEAR MATTER. R. E. Peierls (Oxford Univ.). Endeavour, 22: 146-50(Sept. 1963).

The study of matter has gone through four stages of refinement. First, it was concerned with matter in bulk; second, with atoms as a whole; third, with the outer shells of atoms; and fourth, with the nucleus. Although these different levels of inquiry pose their own problems, they also have certain affinities. The concepts of classical physics, and those developed later to account for phenomena in atomic physics, have their place in interpreting the properties of nuclear matter. To the latter can be ascribed such familiar properties as density, surface tension, and specific heat, and a shell structure analogous with that of atoms. (auth)

40003 EFFECTS OF FINITE NUCLEAR DIMENSIONS ON PARTICLE POLARIZATION AT ELECTRON BREMSSTRAHLUNG AND PAIR FORMATION. F. S. Sadykhov. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz. Mat. i Tekhn. Nauk, No. 2, 55-9(1963). (In Azerbaidzhan)

Investigations were made of the influence of finite nuclear dimensions on angular and longitudinal spin correlations between an electron and a γ quantum, and between an incoming polarized γ quantum and an electron-positron pair. Cross section relations to the positron emission angle are found for C^{12} at Σ_γ = 50 Mev and E_+ = 35 Mev. It is shown that finite angular dimensions have a more pronounced effect on the angular distribution of electron-positron pairs longitudinally polarized in $S_- = S_+$ direction than on non-polarized pairs. With increased positron emission angle the angle of distribution for opposite polarization ($S_- = -S_+$) reduces slower than the distribution angle for polarized pairs. (R.V.J.)

40004 LIFETIME OF THE FIRST EXCITED STATE IN Ti^{48}. A. F. Akkerman, V. L. Kochetkov, V. N. Chekanov, G. V. Oslopovskikh, V. A. Suvorov, and A. K. Shtol'ts. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 285(July 1963). (In Russian)

The lifetime of the first excited state in Ti^{48} was previously measured by several investigators. Disagreement exists between the various published values of the lifetime. The lifetime was measured again using the resonant self-absorption method. A 15 mC source of V^{48} was prepared by bombarding natural titanium with 13-Mev deuterons for about 15 hr. The width of the state was measured to be $(9.47 \pm 2.89) \times 10^{-5}$ ev, corresponding to a lifetime of $(4.92 \pm 1.52) \times 10^{-12}$ sec. (TTT)

40005 ENERGY LEVELS IN NONSPHERICAL ODD-MASS ATOMIC NUCLEI. A. S. Davydov (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 851-61 (July 1963). (In Russian)

A summary is presented for the current models used to calculate energy levels in deformed odd-mass nuclei. The Nilsson scheme is discussed. In this scheme the spheroidal nucleus is assumed to have axial symmetry and the internal motion of the odd nucleon in the nonspherical field of the core is assumed to be separable from collective motions. The case where the two types of excitations, rotational and single particle, interact through a spin-orbital coupling of the odd nucleon with the nonspherical field is also considered. This is discussed for both axially asymmetric nuclei. For nonaxial nuclei the γ deformation parameter is allowed to be different from zero. The scheme is used for calculating energy levels in the mass region from 17 to 39. Diagrams are shown comparing calculated and experimental energy levels, spins and parities for P^{29}, Si^{29}, and P^{31}. It was concluded that because of the coupling between single particle and collective motions the angular momentum number K and its projection on the symmetry axis Ω cannot characterize exactly the properties of an excited level. It is necessary to take into account the complex interaction between rotational and single particle states of the same parity. Such calculations can lead to not only the spins and energies of excited levels but their wave functions as well. (TTT)

40006 LIFETIME OF THE 2+ (880 kev) STATE IN Ti^{46}. A. F. Akkerman, V. L. Kochetkov, and V. N. Chekanov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 862-4(July 1963). (In Russian)

The method of resonant scattering of gamma quanta was used to measure the lifetime of the 2+ (880 kev) state in Ti^{46}. A sample of scandium chloride was irradiated with neutrons, and a total of 15 mC of Sc^{46} activity was produced. Sodium iodide crystals, 40 × 40 cm in size, served as the gamma detectors. The outputs of the crystals were fed into two single-channel analyzers. The width of the state was found to be $(8.39 \pm 2.23) \times 10^{-5}$ ev. This width corresponded to a lifetime of $(5.45 \pm 1.45) \times 10^{-12}$ sec. Comparison with the single-particle value indicated that the transition is strongly enhanced, with F = 19. The enhancement suggests that the 2+ state must be collective in nature. (TTT)

40007 STATES IN C^{12} AND O^{16} OBSERVED DURING THE INVESTIGATION OF CAPTURE CROSS SECTIONS FOR GAMMA-QUANTA IN THE GIANT RESONANCE REGION. N. A. Burgov, G. V. Danilyan, B. S. Dolbilkin, L. E. Lazareva, and F. A. Nikolaev (Inst. of Theoretical and Experimental Physics, State Commission for Peaceful Uses of Nuclear Energy, USSR and Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 866-74 (July 1963). (In Russian)

A magnetic pair spectrometer was employed to measure gamma capture cross sections in C^{12} and O^{16} in the energy region 13 to 27 Mev. The transmission technique was used for the measurements which were carried out in steps of 175 kev. A 250-Mev electron synchrotron was used to produce the x rays with a maximum energy of 200 Mev. In the C^{12} results, three peaks were noted at 16.5, 17.6, and 19.1 Mev. In addition, two broad maxima were observed at about 22.5 and 25.5 Mev with approximate widths of 3.5 and 2.0 Mev, respectively. The peaks correspond to known states in C^{12}. The two broad maxima are assumed to be composed of several resonances. Four peaks were observed in the O^{16} results at 22.3, 23.05, 24.3, and 25.15 Mev. Some indications of peaks were observed at 17.5, 19.4, and 21.2 Mev, though the data at these energies were too sparse to make unambiguous assignments. States in O^{16} are known to exist that correspond to all seven of the observed peaks. (TTT)

40008 ANGULAR DISTRIBUTION OF 100.09-kev GAMMA-RAYS RESONANTLY SCATTERED BY W^{182} NUCLEI. A. V. Davydov and V. P. Selyutin (Inst. of Theoretical and Experimental Physics, State Commission for Peaceful Uses of Nuclear Energy, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 875-7(July 1963). (In Russian)

The angular distribution of resonantly scattered 100.09-kev gamma rays was determined. The purpose was to investigate the possibility of using the Mössbauer effect for the determination of the g-factor of excited nuclear levels by studying the effect of an external magnetic field on the angular distribution of resonantly scattered gamma rays. The difference in counting rate of the gamma spectrum was measured with and without the magnetic field with the detector set at 90°. Then the angular distribution was obtained by counting the gamma rays at 90, 112, 127, 140.5, and 150°. The experimental data were fitted by a theoretical curve assuming the ground state to be of spin 0 and the excited state spin to be 2. It was concluded that for a magnetic field with H ≥ 20,000 Oe one can measure excited state g-factors to within 10% if the mean lifetime of the state is a about 10^{-9} sec, the magnetic moment is about 0.8 nuclear magnetons, and the angular distribution has an anisotropy comparable to the one found in this instance. (TTT)

40009 CONCERNING THE ACCURACY OF THE DETERMINATION OF STATES IN STRONGLY DEFORMED NUCLEI ON THE BASIS OF THE SUPERCONDUCTIVITY MODEL. M. K. Volkov, A. Pavlikovskii, V. Rybarska, and V. G. Solov'ev (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 878-90(July 1963). (In Russian)

The exactness of the mathematical method based on the Bogolyubov canonical transformation and used for the calculation of properties of states in strongly deformed nuclei was investigated. The method was checked for calculations of energy levels of single- and two-quasiparticle states in systems consisting of odd and even numbers of nucleons, respectively. The method was also checked for corrections that are connected with superconducting properties of states and that enter into alpha, beta, and gamma transition probabilities. Four important uncertainties are introduced: the density function is assumed to be diagonal; the interaction that enters into pair correlations, G, is considered to be independent of the quantum numbers and is thus assumed to be a constant; the accuracy with which the average field states are calculated; and the precision of the mathematical method. It is shown that the accuracy of such calculations is limited basically by the leak of knowledge of the behavior of the central field states and their fluctuations and not by the mathematical method. The errors introduced into the calculation of the quasiparticle states is about 10 to 20%, while the error entering into the transition probability corrections is approximately 10 to 100%. (TTT)

40010 CALCULATION OF NUCLEAR RADII FROM ALPHA-DECAY THEORY TAKING INTO ACCOUNT PAIR CORRELATIONS OF THE SUPERCONDUCTING TYPE. T. Veresh (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 891-4(July 1963). (In Russian)

The influence of pair correlations of the superconducting type on the radii derived from alpha decay was investigated. Nuclear radii were calculated for heavy element alpha emitters ranging from Th^{230} to Fm^{254}. The surface probability, SP, and the reduced width, δ_0^2, were also determined for these nuclei. Calculations made in this manner led to a decrease of about 2 Fermis in nuclear radii and thus did away with the disagreement existing between calculated and experimental nuclear radii determined from alpha decay. It was found that alpha-decay radii can be described by a formula of the type $R = r_0 A^{1/3}$, where r_0 is approximately 1.19 Fermis. (TTT)

40011 CLARIFICATION OF THE In^{116} DECAY SCHEME. V. S. Pavlov, G. V. Danilyan, and I. Ya. Korol'kov (Inst. of Theoretical and Experimental Physics, State Commission for Peaceful Uses of Nuclear Energy, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 895-9(July 1963). (In Russian)

The decay schemes of the In^{116} ground state (15 seconds) and its isomeric state (54 min) were investigated by using a magnetic spectrometer. The In^{116} was produced by circulating a solution of $In(NO_3)_3$ from one ampule, situated in a reactor, to another ampule which served as the source for the spectrometer. The time for each complete cycle was about 50 sec. The irradiation time was about 20 sec, while the time for travel between ampule and source was about 8 sec. Measurements were made for gamma energies from 0.7 to 1.8 Mev in 13-kev steps. A previously unreported 1.75-Mev gamma ray was found and assigned to a transition in Sn^{116} which de-excites a proposed level at 3.02 Mev. This level is fed in the 250-kev beta decay of the 54-min isomer. (TTT)

40012 CHARACTERISTICS OF QUASISTATIONARY STATES OF A CONTINUOUS SPECTRUM IN THE REAL WOOD–SAXON POTENTIAL FOR NUCLEI WITH A FROM 5 TO 240. V. E. Kolesov and V. L. Korotkikh (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 900-2 (July 1963). (In Russian)

The location of single-particle states was calculated for nuclei with mass numbers from 5 to 240 by the use of reasonably chosen parameters for a single-particle potential. For the determination of the energies and widths of these quasistationary single-particle states the phase was calculated for the elastic scattering of neutrons on nuclei with spin zero. The Wood–Saxon potential parameters were chosen as follows: $V_0 = 49.8$ Mev, $R = 1.24\ A^{\frac{1}{3}}$ Fermis, $a = 0.646$ Fermis, and $\varkappa = 0.28$ (Fermis)^2. The energy dependences of bound and quasistationary states were determined and plotted as a function of the potential radius, i.e., the parameter X_0. The widths of the quasistationary states were calculated and indicated on the graphs in the following steps: 0 to 100, 100 to 500, and greater than 500 kev. (TTT)

40013 ELASTIC SCATTERING OF NEUTRONS ON THE NUCLEI O^{16} AND C^{12}. V. E. Kolesov, V. L. Korotkikh, and V. G. Malashkina (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 903-6(July 1963). (In Russian)

The influence of the Wood–Saxon potential diffusivity parameter on the characteristics of neutron elastic scattering was examined. The investigation was carried out on a computer. The potential was allowed to be either real or imaginary, and the value of l was allowed to vary up to a maximum value of 10. A change in the diffusivity parameter was found to result in a shift in the level energy and in the level width. The results were applied to the specific cases of neutrons (with energies less than 3 Mev) scattering on C^{12} and O^{16}. The following were chosen for the optical model parameters: for O^{16}, $V_0 = 48.0$ Mev, $R = 3.40$ F, $a = 0.5$ F, and $\varkappa = 0.346 \times 10^{-26}$ cm^2; for C^{12}, $V_0 = 50.0$ Mev, $R = 3.235$ F, $a = 0.40$ F, and $\varkappa = 0.363 \times 10^{-26}$ cm^2. It was found that scattering off the Wood–Saxon potential with the spin-orbit interaction explained not only the general decrease of the scattering cross section with increasing energy, but also the position and characteristics of single-particle quasistationary states. (TTT)

40014 CONCERNING THE ANOMALOUSLY STABLE ABOVE-THRESHOLD STATES IN THE NUCLEI C^{13} AND N^{13}. A. N. Boyarkina and I. Rotter (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 907-13(July 1963). (In Russian)

In the description of the reaction $N^{14}(p,2p)C^{13}$ attention was brought to a possible state, $\frac{5}{2}^-$, in C^{13} which should correspond to a strong transition $N^{14} \rightarrow C^{13}$. This state is expected to lie at about 6-Mev excitation. A search was made for the $\frac{5}{2}^-$-state in C^{13} and N^{13}. Results and calculations were analyzed for data obtained in elastic scattering, pick-up and stripping reactions, gamma excitations, inelastic scattering, and beta decay. The fact that the states were not discovered is considered not fortuitous. It follows not from the disagreement between theory and experiment but rather from the fact that the experimental methods were inadequate due to the strong anomalous nature of these states. It was concluded that the study of (p,2p) reactions with fast protons is probably the best way of obtaining spectroscopic information concerning the fine structure of hole excitations in nuclei. (TTT)

40015 EXCITATION FUNCTIONS FOR NUCLEAR REACTIONS INDUCED BY THE BOMBARDMENT OF Bi^{209} WITH FAST PROTONS. B. I. Belyaev, A. V. Kalyamin, and A. N. Murin. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 923-6(July 1963). (In Russian)

Cross sections were measured for various products resulting from the bombardment of Bi^{209} with protons ranging from 0.135 to 10 Bev in energy. Targets consisting of either bismuth oxide or metallic bismuth were irradiated with protons accelerated in the synchrocyclotron and in the synchrophasotron of the Joint Institute for Nuclear Research. Forty-eight bombardments were carried out; these ranged in duration from 15 min to 4 hr. Chemical separations were performed, and the various fractions were counted using an alpha ionization chamber, a NaI gamma spectrometer, and a 4π gamma and K x-ray counter. Absolute cross sections were measured by using the $Al^{27}(p,3pn)Na^{24}$ reaction as the monitor. The investigated products ranged from Po^{210} to Cu^{67}. In all, forty-three radioactive products were studied. It is planned to use these data for the determination of the parameters that enter into the interpolation formulas of Turkevich and Rudstam. The data may also serve to illuminate the mechanisms involved in the production of different nuclides by the interaction of fast protons with heavy nuclei. (TTT)

40016 INELASTIC SCATTERING OF DEUTERONS ON SEVERAL ISOTOPES OF CHROMIUM, ZINC, AND TIN. O. F. Nemets and V. V. Tokarevskii (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 927-31(July 1963). (In Russian)

The differential cross section was measured for the inelastic scattering of 13.6-Mev deuterons on the following nuclei: Cr^{50}(0.79 Mev), Cr^{52} (1.42 Mev), Zn^{64} (0.98 Mev), Zn^{68} (1.02 Mev), Zn^{70} (1.0 Mev), and Sn^{116} (1.2 and 2.3 Mev). The scattered deuterons were detected with a CsI scintillation spectrometer by using the dE/dX vs. E method. The experimental differential cross sections were compared with calculations from the theories of Huby and Newns and of Mullin and Guth. Neither of the two calculations was found to fit the data at all angles. The position of the peaks, however, predicted from theory coincided well with the measured maxima in the angular distribution. (TTT)

40017 TABLES OF GAMMA-RAY AND BETA-RAY SPECTRA OF FISSION PRODUCTS. L. Albrecht (VEB Entwicklung and Projektierung Kerntechnischer Anlagen, Berlin). Kernenergie, 6: 390-1(Aug. 1963). (In German)

A collection of the β and γ spectra of fission products is presented in tabular form. The fission products considered have half lives of between 15 sec and 100 yr. The state of the literature index corresponds to about August 1962. (tr-auth)

40018 β-γ-CIRCULAR POLARIZATION CORRELATION OF Sc^{46} AND CHEMICAL FORM OF THE SOURCE. H. Daniel (Max-Planck-Institut für Kernphysik, Heidelberg), O. Mehling, O. Mueller, P. Schmidlin, H. Schmitt, K. S. Subudhi, and E. Neuburger. Nucl. Phys., 45: 529-54(Aug. 1963). (In German)

The β-γ-circular-polarization correlation of Sc^{46} was measured by means of forward Compton scattering. Solid scandium sources of the following compounds were investigated: oxide, chloride, nitrate, sulfate, metals, and ammoniumfluoscandiate. Furthermore, a number of thin liquid sources were measured: chloride in diluted hydrochloric acid, acetylacetonate in m-xylene, and acetylacetonate in methylene bromide. A liquid mixed source of Co^{60} and Sc^{46} was also measured. A total of 15 sources were investigated. The results of the individual sources are, within statistics, all in agreement with each other, and in the same way with

the earlier Heidelberg and Livermore results. The observed correlations turned out to be, within statistics, completely independent of the age of the source. The anisotropy parameter A of the β-γ circular-polarization correlation, averaged over all sources, was found to be A = 0.113 ± 0.008 (standard deviation, including calibration error), which implies a ratio X between Fermi and Gamow-Teller contributions of X = −0.040 ± 0.011. In supplementary runs, the β-γ directional correlation as well as the γ-γ directional correlation were measured, the latter with chloride and sulfate sources. The β-γ directional correlation was found to be isotropic while the γ-γ correlation was found to have the anisotropy expected for a non-attenuated E2 cascade. In appendices the problems of estimating source thickness effects on the measured angular distribution of electrons from oriented nuclei, on the measured β-γ circular-polarization correlation, and on the measured β-γ directional correlation are treated, as well as the problem of measuring random coincidences in a fast-slow coincidence circuit. (auth)

40019 A SEMI-CLASSICAL DESCRIPTION OF NUCLEAR SURFACE OSCILLATIONS. P. Van Leuven (Centre d'Etude de l'Energie Nucleaire, Mol. Belg.). Nucl. Phys., 45: 561-72(Aug. 1963). (In English)

Stationary states are obtained for a Hamiltonian having an almost periodic time dependence. Eigenfrequencies and inertial parameters for an oscillating system are related to the properties of the equilibrium form. The method is used to study the relation between collective nuclear vibrations and the shell model. Applications to quadrupole and octupole vibrations of closed-shell nuclei with A ≦ 60 are discussed. (auth)

40020 GAMMA-GAMMA ANGULAR CORRELATIONS IN Re^{187}. W. Michaelis (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys., 45: 573-8(Aug. 1963). (In English)

Angular correlation measurements were made on the 72-134 kev and 552-134 kev gamma-ray cascades in Re^{187} following the decay of 24 h W^{187}. The observed correlation functions are $W(\theta) = (1 \pm 0.004) - (0.047 \pm 0.024)P_2(\cos\theta) + (0.004 \pm 0.041)P_4(\cos\theta)$ and $W(\theta) = (1 \pm 0.006) - (0.034 \pm 0.017)P_2(\cos\theta) - (0.007 \pm 0.030)P_4(\cos\theta)$, respectively, for the two cascades. The results are consistent with the spin values $^9/_2$ and $^5/_2$ for the excited energy levels at 206 and 686 kev, respectively. The above correlation functions are considerably different from those reported by Behrend and Neuert for the 72-134 kev cascade and by Arns and Wiedenbeck for the 552-134 kev cascade. (auth)

40021 $Li^7(p,\gamma)Be^8$ EXCITATION CURVE FROM 1.5 Mev TO 11 Mev. R. R. Perry, B. Mainsbridge, and J. Rickards (Rice Univ., Houston, Tex.). Nucl. Phys., 45: 586-92(Aug. 1963). (In English)

The $Li^7(p,\gamma)Be^8$ reaction was studied from 1.5 to 11 Mev bombarding energy using the proton beam from the Rice tandem Van de Graaff accelerator. The sum of the gamma rays leading to the ground and first excited states of Be^8 shows a giant resonance peaked at 7.3 Mev with a possible secondary peak at 6 Mev bombarding energy. Five angular distributions were measured below 7 Mev and showed isotropy within 25% in all cases. A tunnel diode discriminator and linear gating circuit were used to prevent excessive pile-up from neutron capture in the NaI(Tl) crystal. To further reduce the background, nearby slits were dispensed with and the beam was stopped 10 m away from the target. (auth)

40022 GAMMA-RAY WIDTHS OF THE 2.21 Mev LEVEL IN Al^{27}. V. J. Vanhuyse and G. J. Vanpraet (Rijksuniversiteit, Ghent). Nucl. Phys., 45: 602-8(Aug. 1963). (In English)

The bremsstrahlung spectrum of 2.85-Mev electrons from a linear accelerator was used to excite the 2.21-Mev level of Al^{27}. From the results of resonance self-absorption the value $g\Gamma = (1.8 \pm 0.4) \times 10^{-3}$ ev was obtained. The angular distribution of the 2.21-Mev resonance radiation was found to be of the form $W(\theta) = 1 + (0.26 \pm 0.05)P_2(\cos\theta)$. The results are interpreted in terms of the collective model. (auth)

40023 ISOMERIC LEVELS IN THE LIGHT THALLIUM ISOTOPES. R. M. Diamond and F. S. Stephens (Univ. of California, Berkeley). Nucl. Phys., 45: 632-46(Aug. 1963). (In English)

A study was made of the metastable states produced in certain heavy-ion reactions by observing the gamma-ray and conversion-electron transitions occurring between the beam bursts of the HILAC at the Lawrence Radiation Laboratory. Targets and projectiles were chosen which produce thallium isotopes ranging from mass 200 to mass 191. New E3 isomers were found in Tl^{200}, Tl^{199}, and Tl^{193}. The isomer in Tl^{200} is apparently a 7^+ level, in close analogy with other known even-mass thallium isotopes. Considerable evidence was accumulated that in the odd-mass thallium nuclei, including the previously studied Tl^{197} and Tl^{195}, the metastable state has spin and parity $^9/_2^-$. Such a state is not expected to occur at low energies in these nuclei, and its nature, therefore, presents an interesting problem. (auth)

40024 THE ELASTIC SCATTERING OF DEUTERONS BY O^{16} FROM 0.65 TO 2.0 Mev. R. F. Seiler, C. H. Jones, W. J. Anzick, D. F. Herring, and K. W. Jones (Ohio State Univ., Columbus). Nucl. Phys., 45: 647-56(Aug. 1963). (In English)

Absolute cross sections for the elastic scattering of deuterons by O^{16} were measured at seven center-of-mass angles from 0.65 to 2.0 Mev. Absolute cross sections for the $O^{16}(d,p_0)O^{17}$, $O^{16}(d,p_1)O^{17}$, and $O^{16}(d,\alpha_0)N^{14}$ reactions were measured at a laboratory angle of 164°15′. (auth)

40025 SOME EFFECTS OF FORM FACTOR DISTORTION IN THE NUCLEAR OPTICAL MODEL. H. F. Lutz and J. B. Mason (Univ. of California, Livermore). Nucl. Phys., 45: 657-64(Aug. 1963). (In English)

The effects of depressing and raising the real part of the central nuclear potential in the optical model are investigated by numerical studies. It is shown that elastic scattering data do not determine the shape of the interior of the nuclear potential and that one may say that polarization studies probe the nuclear surface only after adopting some standard shape for the interior, which is assumed valid for all nuclei. The shape of the back angle portion of the polarization curves is discussed and some practical applications are suggested. (auth)

40026 THE DECAY OF MERCURY 192. Jerzy Jastrzebski and Pierrette Kilcher (Faculte des Sciences, Orsay, France). Nucl. Phys., 45: 679-95(Aug. 1963). (In French)

The decay of isotopically separated Hg^{192} was studied in order to obtain information about the excited levels of the odd nucleus Au^{192}. The measurements were performed with the aid of an intermediate focussing β-spectrometer, a semi-circular β-spectrograph and scintillation techniques; 26 γ transitions were found in the decay of Hg^{192}. By means

of coincidence measurements and sum relations a level scheme of Au^{192} is proposed. For some firmly established levels, the odd particle configurations are discussed using the shell model and the Nilsson model. (auth)

40027 ACTIVATION CROSS-SECTIONS FOR Na^{23} AND Al^{27} WITH 14 Mev NEUTRONS. J. Csikai, B. Gyarmati, and I. Hunyadi (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Nucl. Phys., 46: 141-4(July 1963). (In English)

The activation cross section of the reactions (n,α), (n,p), and (n,2n) were determined for Al^{27} at 14.6 Mev neutron energy. The values obtained were 118 mb, > 2 mb, 0.56 mb, and < 0.17 mb, respectively. In the case of Na^{23}, for the cross section ratio of the reactions (n,α) and (n,p) a value $\sigma_{n\alpha}/\sigma_{np} = 3.9 \pm 0.3$ was obtained. The data are compared with calculations based on the statistical model. (auth)

40028 EXCITATION OF THREE-PHONON VIBRATIONAL STATES BY INELASTIC α-PARTICLE SCATTERING. C. Quesne (Université Libre, Brussels). Nucl. Phys., 46: 145-52(July 1963). (In English)

The differential cross section for direct excitation by α-particle scattering of three-phonon vibrational states in spherical even nuclei was calculated by means of the plane-wave Born approximation. A selection rule characterizing the scattering of zero spin particles by zero spin nuclei restricts the excitation to states of natural parity. Two corrections are introduced to prevent the nuclear volume change and, in the case of vibrations of odd multipolarity, the center-of-mass shift of the target nucleus. When the interaction involves only a pure multipolarity λ, the former is found to influence the excitation of the states with I = 0 or λ and the latter that of the 1^- state. (auth)

40029 ALPHA PARTICLES PRODUCED BY THE SPALLATION OF BISMUTH BY PROTONS OF 240 TO 600 Mev. Marc Lefort and Xavier Tarrago (Faculté des Sciences, Paris). Nucl. Phys., 46: 161-70(July 1963). (In French)

From secondary reaction measurements on bismuth nuclei bombarded by high energy protons, the cross sections for α-particle emission were deduced. The values are 110, 220, and 320 mb at incident energies of 240, 420, and 550 Mev, respectively. The energy distributions of α-particles emitted in the forward or in the backward directions were determined, and it could be shown that the following two processes are involved: An isotropic emission in the center-of-mass system, the cross section of which increases from 25 to 210 mb when the incident energy goes from 240 to 550 Mev. A process in which α-particles are emitted mainly in the forward direction. Calculations were carried out with an IBM 7094 computer, assuming that α substructures are knocked-out from the surface of the nucleus by cascade nucleons. The probability for the occurrence of such α structures was found to be 0.7 ± 0.1. (auth)

40030 TENSOR-FORCE AND SPIN-ORBIT COUPLING IN THE FRAMEWORK OF THE HARTREE-FOCK THEORY. J.-P. Amiet and P. Huguenin (Universität, Bonn). Nucl. Phys., 46: 171-80(July 1963). (In English)

A method is developed which introduces into the framework of the Hartree-Fock theory a mixture of one-particle states of opposite parities. Eventually it provides a state function of definite parity that is a sum of two Slater determinants. With this method, an important contribution of the tensor-force occurs in the Hartree-Fock equation in the form of an additional spin-dependent potential, which provides a spin-orbit splitting of the required order of magnitude. (auth)

40031 NUCLEON-NUCLEON POTENTIAL FROM SHELL MODEL CALCULATIONS FOR DOUBLET SPLITTINGS. P. C. Sood and Y. R. Waghmare (Panjab Univ., Chandigarh, India). Nucl. Phys., 46: 181-92(July 1963). (In English)

The residual interaction responsible for the occurrence of certain closely spaced doublets in nuclei with a $p_{1/2}$-nucleon coupled to a core of spin j is sought to be represented by an effective nucleon-nucleon potential. After justifying the dropping of the hard core and the noncentral terms, the two-body potential is chosen to be static, nonsingular and central in character. The radial dependence is chosen to be of the Gaussian form. The relation between the parameters of an explicitly spin-dependent potential and those of the general exchange mixture is pointed out. The potential parameters are fixed by comparison of the observed splitting for $p_{1/2}$-doublets with the theoretical results. The splittings for doublets in the T = 1 isobaric state occurring in the neutron-neutron or proton-proton system are satisfactorily explained assuming a Serber exchange mixture although a sizable triplet odd force is not ruled out. The results obtained from such systems are compared with those from the neutron-proton system to fix the parameters for the spin-dependent potential. Several levels or doublets in the nuclei Y^{88}, Zr^{90}, Nb^{90}, N^{14}, Y^{90}, Tl^{206}, and Bi^{208} are predicted. The extension of the treatment to three-particle doublets is discussed for the levels of Nb^{91}. (auth)

40032 PHASE SHIFTS FOR SINGULAR TYPE NUCLEON-NUCLEON TRIPLET-EVEN POTENTIALS. T. Gajewski (Univ. of Lodz, Poland). Nucl. Phys., 46: 203-9(July 1963). (In English)

Applying the method developed in two previous papers, some formulas are derived for the triplet phase shifts of the scattering by the singular nucleon-nucleon potentials $\propto \exp(-x)/x^n$. These formulas give the triplet phase shifts in terms of the known modified Bessel functions of the third kind and the modified Struve functions. The values of the phase shifts obtained by means of these formulas prove to be in good agreement with the results of the corresponding numerical calculations. (auth)

40033 WIDTH OF THE 2^+ 1.77 Mev LEVEL IN Si^{28}. S. J. Skorka and T. W. Retz-Schmidt (Universität, Hamburg). Nucl. Phys., 46: 225-32(July 1963). (In English)

Nuclear resonance fluorescence techniques were used to measure the width of the first excited state in Si^{28}. The Doppler broadened gamma rays from the $Si^{28}(p,p')$ reaction served as a gamma source. The self-absorption experiment yielded $\Gamma = (0.92 \pm 0.08) \times 10^{-3}$ ev, corresponding to a mean life of $\tau_m = (7.2 \pm 0.6) \times 10^{-13}$ sec. The result of the scattering experiment is discussed in terms of slowing-down effects of the silicon recoils in the target. (auth)

40034 BETA DECAY ENERGIES OF V^{52} AND Cr^{55}. D. G. Megli and T. T. Thwaites (Pennsylvania State Univ., University Park). Nucl. Phys., 46: 233-5(July 1963). (In English)

The beta spectra of V^{52} and Cr^{55} were measured with a scintillation spectrometer. Kurie plots of the spectra yield end-point energies of 2.47 ± 0.04 and 2.50 ± 0.04 Mev for V^{52} and Cr^{55}, respectively. (auth)

40035 INVESTIGATION OF THE DECAY SCHEME OF Cr^{51}. Gy. Máthé (Inst. of Nuclear Research, Hungarian

Academy of Sciences, Debrecen). Nucl. Phys., 46: 236-40(July 1963). (In English)

The energy distribution of γ rays arising from the decay of Cr^{51} was investigated by the scintillation method. Besides the well-known, most intense transition of 323 kev, the 323 and 320 kev cascade transitions of low intensity were found. At 150 kev a new γ transition in cascade with the line of 323 kev was found. A cross-over transition of 470 kev energy was observed in parallel with the cascade. (auth)

40036 THE SHELL MODEL AND DEUTERON STRIPPING. M. H. Mittleman (Univ. of California, Berkeley) and Toshio Soda. Nucl. Phys., 46: 241-5(July 1963). (In English)

Ambiguities in the present formulation of stripping reactions are pointed out. The transition to the shell model approximation of the nucleus is also carried out in the transition matrix for stripping. The A^{-1} corrections are obtained and it is seen that previous formulations of these corrections are incorrect. (A = mass number of the target nucleus). (auth)

40037 THE MAGNITUDE OF EXCHANGE EFFECTS IN (d,p) REACTIONS. Leonard S. Rodberg (Univ. of Maryland, College Park). Nucl. Phys., 47: 1-10(Aug. 1963). (In English)

The angular distributions in (d,p) reactions are frequently interpreted in terms of deuteron stripping, heavy particle stripping and knock-on processes. It is shown that, in general, distortion effects cause the heavy particle stripping cross section to be of order 1/A compared to the deuteron stripping cross section. The knock-on cross section is also shown to be smaller and less sharply peaked than the deuteron stripping cross section when proper account is taken of the finite size of the deuteron. Thus only when special selection rules suppress the contribution of deuteron stripping are these exchange effects important. (auth)

40038 THE INTERACTION OF FAST PARTICLES WITH NUCLEI. K. D. Tolstov (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., 47: 11-18(Aug. 1963). (In English)

It is shown that the dispersion of proton momenta in inelastic p-N-collisions for 9 Bev and π^--N-collisions for 7 Bev as well as data on inelastic collisions with proton nuclei for 9 to 27 Bev agree with the mechanism of successive collisions of an incident particle with the nucleons in the nucleus. The methods and conclusions that deal with collisions with nuclei are discussed for comparison. It is shown that several negligences in these methods affect the conclusion on the validity of the tunnel mechanism and the difference in the inelasticity coefficients in the interval of 2 to 27 Bev. (auth)

40039 ALPHA-PARTICLES FROM SEVERAL ELEMENTS BOMBARDED WITH 30, 43 AND 56 Mev PROTONS. Jiro Muto, Hidehiko Itoh, Kotoyuki Okano, Naoko Shiomi, Kyue Fukuda, Yasuya Omori, and Motohiro Kihara (Kyoto Univ.). Nucl. Phys., 47: 19-32(Aug. 1963). (In English)

Several elements were bombarded with 30, 43, and 56 Mev protons from the INS(Tokyo) synchocyclotron. Energy spectra and angular distributions of emitted α particles were measured by an emulsion camera. The dependence of total cross sections, angular distributions and peak energies of the spectra on the bombarding energy as well as the atomic number of target nuclei is described. The cross sections were separated into two parts, the direct process and the compound process. Energy spectra ascribed to the direct process are not inconsistent with the picture of knockout process of quasi-free α particles. (auth)

40040 EXCITED LEVELS OF EVEN-MASS NUCLEI OF THE TRANSITIONAL REGION $82 < N < 92$. V. N. Lutsenko (Kurchatov Atomic Energy Inst., Moscow). Nucl. Phys., 47: 42-55(Aug. 1963). (In English)

The excited levels with energies up to 2 Mev in even-mass nuclei with neutron number $82 < N < 92$ are analyzed. Nuclei with $N > 82$ are found to have the level sequence 0^+, 2^+, 4^+, and 6^+ whose properties change smoothly with N. In strongly deformed nuclei this sequence passes into the main rotational band. Bands analogous to the β and γ vibrational bands of strongly deformed nuclei are also found for nuclei with $N = 88$. The position and radiation properties of the levels are compared with the predictions of some models of even-mass nuclei. (auth)

40041 THE $C^{13}(d,p)C^{14}$ REACTION. J. C. Lisle, J. O. Newton, W. R. Phillips, and F. H. Read (Univ. of Manchester, Eng.). Nucl. Phys., 47: 56-64(Aug. 1963). (In English)

Differential cross-section measurements at five bombarding energies in the range from 4.6 to 6.0 Mev, excitation function measurements at two angles, and two p-γ angular correlation measurements at a bombarding energy of 6.0 Mev, were made for the reaction $C^{13}(d,p)C^{14}$ leading to the first excited state at 6.09 Mev. Except for the appearance of some resonance structure in the excitation functions the results are in reasonable agreement with the predictions of the DWBA theory of direct interactions with s-wave neutron capture. (auth)

40042 OPTICAL MODEL OF LOW ENERGY NEUTRON INTERACTIONS WITH SPHERICAL NUCLEI. P. A. Moldauer (Argonne National Lab., Ill.). Nucl. Phys., 47: 65-92(Aug. 1963). (In English)

The optical model is used to study available data on the absorption, scattering, and polarization by spherical nuclei of neutrons with energies below 1 Mev. A good fit is obtained with a diffuse surface model having a sharply peaked absorptive shell at the surface. The sensitivity of various cross sections to changes in optical model parameters is discussed, both qualitatively and quantitatively. (auth)

40043 SOME GAMMA RAYS OF Cd^{115m}. J. P. Hurley, R. M. Brown, and C. E. Mandeville (Naval Radiological Defense Lab., San Francisco). Nucl. Phys., 47: 93-7(Aug. 1963). (In English)

The spectrum of the harder gamma rays of In^{115} was investigated by utilization of scintillation counters and multi-channel analysis. The gamma ray of quantum energy 1.14 Mev is found to be emitted in (0.081 ± 0.002) percent of the disintegrations, and the gamma ray at 1.41 Mev in (0.035 ± 0.002) percent of the disintegrations. These results are interpreted as showing evidence of the presence of at least two levels in the near vicinity of 1.4 Mev in the level scheme of In^{115}. Precautions were taken to eliminate summing effects and contributions from K^{40}. (auth)

40044 VIBRATIONS OF NON-SPHERICAL NUCLEI. M. G. Urin (Moscow Physical Engineering Inst.) and D. F. Zaretskii. Nucl. Phys., 47: 97-107(Aug. 1963). (In English)

The vibrational levels of nonspherical nuclei are studied by a semiclassical method analogous to the cranking model for rotation. The method of Green's one-particle functions is used to describe the superfluidity of nuclei. A dispersion equation is obtained for determining the eigenvalues of

frequencies of the proper vibrations of the mass multipole moments. The mass coefficient for multipole vibrations, obtained with the help of this equation, contains an additional term which makes it possible to derive the hydrodynamic limit. (auth)

40045 TRANSITION INTENSITIES FROM THERMAL (n,γ) IN Be, Al, Cl, Sc, AND Ti. J. E. Draper and C. O. Bostrom (Yale Univ., New Haven). Nucl. Phys., 47: 108-23 (Aug. 1963). (In English)

Gamma transition intensities are reported for thermal neutron capture in Be, Al, Cl, Sc, and Ti in the energy range of 50 kev to 10 Mev. Ten new transitions are discussed. The pulsed neutron source permits discrimination against isomers. (auth)

40046 STATISTICAL FLUCTUATIONS OF COMPOUND NUCLEUS LEVEL DENSITY AND NUCLEAR CROSS SECTIONS. A. Agodi and G. Pappalardo (Università, Catania, Italy). Nucl. Phys., 47: 129-36(Aug. 1963). (In English)

Some neutron cross sections measured with a beam having an energy spread larger than the average level spacing display an irregularly oscillating, resonance-like behavior at excitation energies within 10 and 15 Mev of the intermediate compound system. It is shown that this behavior can be explained, in principle, as due to statistical fluctuations of the compound nucleus level density. The results of an analysis of experimental data reported here are consistent with the proposed explanation. (auth)

40047 TOTAL NEUTRON CROSS SECTION OF CARBON. Kamal K. Seth (Northwestern Univ., Evanston, Ill. and Duke Univ., Durham, N. C.). Nucl. Phys., 47: 137-49 (Aug. 1963). (In English)

An accurate determination of neutron total cross section of carbon was made by the transmission method in the energy region 3 to 660 kev. No structure is observed in the total cross section over the whole energy region, and it is concluded that the upper limit of the width of the proposed level at 610 kev neutron energy must be 10 ev in order to escape detection in the present experiment. The observed total cross section was analyzed in terms of the effective range theory as well as the resonance theory, and the results are found to be in good agreement. The relative reduced width for the bound level at −1.86 Mev (i.e., the 3.09 Mev $2s_{\frac{1}{2}}$ state in C^{13}) is found to be $\theta^2 = 0.2$, and the interaction radius is found to be 4.7 fm. (auth)

40048 THE 5.11 AND 5.16 Mev LEVELS OF B^{10}. P. J. Riley, D. W. Braben, and G. C. Neilson (Univ. of Alberta, Edmonton, Can.). Nucl. Phys., 47: 150-6(Aug. 1963). (In English)

The 5.11 and 5.16 Mev levels in B^{10} were studied using the $Be^9(d,n)B^{10}$ reaction. It is found that the 5.11 Mev state decays almost entirely by alpha emission and is probably a T = 0 state whereas the 5.16 Mev state decays almost entirely by gamma emission and is probably a T = 1 state. Angular distribution measurements were made which indicate that the 5.11 Mev state has $J^\pi = 2^-$, and that the 5.16 Mev state has $J^\pi = 2^+$. No evidence was obtained for the new state postulated at 5.18 Mev. (auth)

40049 ABSOLUTE CROSS-SECTIONS FOR SOME (n,p), (n,α), AND (n,2n) REACTIONS. J. M. F. Jeronymo, G. S. Mani, J. Olkowsky, A. Sadeghi, and C. F. Williamson (Centre d'Études Nucléaires, Saclay, France). Nucl. Phys., 47: 157-76(Aug. 1963). (In English)

The reactions $Al^{27}(n,\alpha)Na^{24}$, $Mg^{24}(n,p)Na^{24}$, $Si^{28}(n,p)Al^{28}$, $Co^{59}(n,p)Fe^{59}$, $Co^{59}(n,2n)Co^{58}$, $Co^{59}(n,\alpha)Mn^{56}$, $Ni^{58}(n,p)Co^{58}$, and $Ni^{58}(n,2n)Ni^{57}$ were studied by an activation method from 12.5 to 21.0 Mev neutron energy. A method of calibrating well-type crystals to obtain absolute efficiency is described. The results for absolute cross sections obtained by this method for the above reactions are compared with statistical model calculations in which the nuclear transmission coefficients were derived from an average optical potential extracted from the scattering data. (auth)

40050 TENSOR FORCES AND THE ENERGY LEVELS OF ^{210}Bi. P. A. Mello and J. Flores (Universidad de Mexico, Mexico City). Nucl. Phys., 47: 177-83(Aug. 1963). (In English)

Recent experiments have given information on the position and angular momenta of the low-energy levels in Bi^{210}. A good fit for these levels is obtained by assuming a Wigner force plus a short-range tensor interaction in a $(2g_{\frac{9}{2}}, 1h_{\frac{9}{2}})$ configuration for the neutron and proton outside the doubly magic Pb^{208}. (auth)

40051 ENERGY LEVELS OF Bi^{210} AND Po^{210} AND THE SHELL-MODEL RESIDUAL FORCE. Yeong E. Kim and John O. Rasmussen (Univ. of California, Berkeley). Nucl. Phys., 47: 184-206(Aug. 1963). (UCRL-10707). (In English)

The low-lying energy level spectra of Bi^{210} and Po^{210} are calculated by using the j-j coupling shell model and a residual nucleon-nucleon Gaussian potential without a hard core deduced from the free two-nucleon potentials of Blatt-Jackson and Brueckner-Gammel-Thaler. The spin-orbit force is neglected, but all direct and exchange components of the central and tensor forces are considered. Tensor-force effects are examined as a function of the range. A tensor force with reasonable range and strength accounts for the 1^- state of the $h_{\frac{9}{2}}g_{\frac{9}{2}}$ multiplet being the ground state of Bi^{210}, instead of the 0^- predicted by central forces. Eigenvalues and eigenfunctions are presented and compared with the experimental spectra. It is shown that the ground-state wave functions for Bi^{210} and Po^{210} are consistent with the RaE β-decay parameter $i(r)/(\sigma \times r)$ and the measured magnetic dipole moment of Bi^{210}. (auth)

40052 POLARIZATION IN THE SCATTERING OF PROTONS BY α-PARTICLES. R. I. Brown, W. Haeberli, and J. X. Saladin (Univ. of Wisconsin, Madison). Nucl. Phys., 47: 212-24(Aug. 1963). (TID-18548). (In English)

Double scattering from helium was used to measure the proton polarization in p-α scattering at laboratory angles of 45.8, 60.8, 75.6, and 115.1° for incident proton energies near 4.7, 5.9, 7.9, 9.9, and 11.9 Mev. For 45.8° additional measurements were made at 3.6, 4.2, and 5.4 Mev. The total uncertainty in the measured polarization varies between ±0.01 and ±0.03. The present measurements indicate that the polarization predicted by the best available sets of phase shifts is in error by as much as 0.08. The deviation is largest at 75.6° and smallest at 115.1°. (auth)

40053 CONTRIBUTION TO THE STUDY OF THE REACTION (n,2n) AT 14 Mev. Hannes Jérémie (Collège de France, Paris). Nucl. Phys., 47: 225-34(Aug. 1963). (In French)

The (n,2n) reaction on H^2, Be^9, and Bi^{209} at 14 Mev was examined by measurement of the time-of-flight spectrum and the angular correlation of the two outgoing neutrons in order to get more information about the contribution of different mechanisms to this reaction. (auth)

40054 CONVERSION ELECTRONS IN THE DECAY OF Ag^{110m} TO Cd^{110}. T. Suter (Comisión Nacional de Energía Atómica, Buenos Aires), P. Reyes-Suter, W. Scheuer, and E. Aasa. Nucl. Phys., 47: 251-6(Aug. 1963). (In English)

The internal conversion spectrum in the decay of Ag^{110m} to Cd^{110} was investigated by means of an iron yoke double

focusing spectrometer. Transitions of the following energies were determined with an accuracy of a few parts in 10^4: 116.25, 436.2, 446.7, 615.8, 620.1, 657.6, 677.3, 686.8, 706.3, 744.0, 763.7, 818.0, 884.5, and 937.3 kev. The transitions quoted as 436.2 and 615.8 kev may correspond to the decay of Ag^{108m} with transition energies of 433.9 and 613.5 kev. (auth)

40055 THE REACTION MECHANISM OF THE C^{13}(d,n) AND C^{13}(d,p) REACTIONS BETWEEN 3.2 AND 4.1 Mev. V. K. Deshpande (Univ. of Rochester, N. Y.). Nucl. Phys., 47: 257-65(Aug. 1963). (In English)

Angular distributions and excitation curves for the C^{13}(d,n)N^{14} and C^{13}(d,p)C^{14} reactions were obtained for E_d between 3.2 and 4.1 Mev. For both cases, the angular distributions peak at 25°, a feature typical of stripping with l = 1. The (d,n) distributions show a secondary maximum at about 80°, which the (d,p) distributions do not show. The excitation curves in both cases show a weak resonance structure at 3.4 Mev. Distorted-wave Born approximation calculation gives a satisfactory fit to the (d,p) angular distributions but predicts similar angular distributions for both (d,p) and (d,n) reactions, contrary to the experimental result. The contribution from processes other than the deuteron stripping processes was considered. (auth)

40056 TOTAL REACTION CROSS SECTIONS OF PROTON INDUCED REACTIONS. J. Delaunay-Olkowsky (CEN, Saclay, France), P. Strohal, and N. Cindro. Nucl. Phys., 47: 266-72(Aug. 1963). (In English)

The total cross sections for proton-induced reactions were studied for several nuclei in the region of A ≈ 100 by the activation technique. The proton energy was 11.2 Mev. The results show that most reaction processes lead to uncharged exit channels. The experimental results were compared with the statistical model. Considerable agreement was found with the experiment for uncharged outgoing particles. The excitation function for the reaction Zr^{90}(p,n)Nb^{90} was measured for proton energies from 6.9 to 11.2 Mev by the stacked-foil method. (auth)

40057 TWO-QUANTUM TRANSITIONS OF ATOMIC NUCLEI. [PART] II. D. P. Grechukhin (Kurchatov Atomic Energy Inst., Moscow). Nucl. Phys., 47: 273-92(Aug. 1963). (In English)

The analysis made previously of two-quantum processes in atomic nuclei is continued. Nuclear γ-γ-transitions are considered taking into account the interference of all channels allowed by the selection rules with respect to the angular momentum and parity of nuclear states $j_1\pi_1$ and $j_2\pi_2$ between which the transition occurs. General formulas of the differential probability $dW_{\gamma\gamma}(\omega_1 k_1; \omega_2 k_2)$ for the radiation of quanta with energies ω_1 and ω_2 and wave vectors k_1 and k_2, and formulas for the quantum spectra and for the total probability of the $\gamma\gamma$-transition are obtained. The functions determining the angular quantum correlation are tabulated for $\gamma\gamma$-transitions competing with the one-quantum ML_0 and EL_0 processes at L_0 = 2.3.4.5. The $\gamma\gamma$-transitions of the nucleus of the (M1M1) (E1E1) and (E1M1) type for which the condition $L_1 + L_2 = |j_1 - j_2| = L_0$ is not fulfilled are considered separately. Formulas for the differential probability for these transitions are obtained and the angular functions are also tabulated. The probability for the $\gamma\gamma$-process is estimated for a model of transition through only one virtual level and also in the random phase approximation. The $\gamma\gamma$-transition probabilities in this model are expressed through the probabilities for nuclear one-quantum radiation transitions from the virtual level to the E_1j_1 and E_2j_2 levels between which the $\gamma\gamma$-process occurs. The formulas obtained make it possible to evaluate the $\gamma\gamma$-transition probability from the experimental data on the nuclear spectrum. (auth)

40058 BETA-GAMMA DIRECTIONAL CORRELATION IN Sb^{124}. S. K. Mitra (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., 47: 293-302(Aug. 1963). (In English)

The directional correlation between the nonunique first-forbidden outer beta group of end-point energy 2.31 Mev in Sb^{124} and the 0.603-Mev cascade gamma ray in Te^{124} was measured at twenty-six beta energies. The measured beta-gamma correlation coefficient ϵ ranges from $-(0.186 \pm 0.016)$ to $-(0.387 \pm 0.010)$ in the beta energy interval 0.95 to 2.20 Mev. Taking into account the existing data on shape correction factor and also the angular dependence of the beta-gamma circular polarization coefficient ω, the relevant first-forbidden beta decay matrix element ratios were extracted; the ratios of the matrix elements are (in Kotani's notation) $x = 0.06 \pm 0.05$, $u = 0.15 \pm 0.05$ and $Y = 1.05 \pm 0.15$. Absolute values of the matrix elements were obtained from the observed log ft value as

$$|\int B_{ij}|/R = (1.0 \pm 0.2) \times 10^{-2}, \; |\int r|/R = (7.5 \pm 6.4) \times 10^{-4},$$
$$|\int i\sigma \times r|/R = (15.5 \pm 5.9) \times 10^{-4}, \; |\int i\sigma| = (7.0 \pm 2.1) \times 10^{-4}.$$

The experimental ratio of $\int i\alpha / \int r$ agrees with the prediction of the conserved vector current theory of beta decay. (auth)

40059 ENERGY LEVELS OF $_{73}Ta^{176}_{103}$. J. Valentin and A. Santoni (Institut du Radium, Orsay, France). Nucl. Phys., 47: 303-12(Aug. 1963). (In French)

The energy levels of the odd nucleus Ta^{176}, populated from the electron capture of W^{176}, were found with high resolution 180° spectrographs and with scintillation techniques. The level scheme is discussed in terms of expected configurations of the 73rd proton and 103rd neutron. (auth)

40060 THE INVESTIGATION OF NONELASTIC CROSS SECTIONS FOR IRON BY THE NANOSECOND PULSED NEUTRON SOURCE TECHNIQUE. L. E. Beghian, A. E. Profio, J. Weber, and S. Wilensky (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng., 17: 82-9(Sept. 1963).

Nanosecond bursts of monoenergetic neutrons in the 1 Mev range are injected into various size assemblies of iron. The flux in these assemblies is observed to decay exponentially with characteristic nanosecond decay constants (λ). λ is shown to be composed of a sum of terms which represent loss of neutrons by leakage and through energy degradation by both nonelastic and elastic scattering. The sum of these two last effects can be represented by a total removal cross section, which can be determined by measuring λ as a function of assembly size. A theoretical development is given for calculating the contribution to this total cross section due to elastic scattering; hence the total nonelastic cross section can be determined. Nonelastic cross sections for iron were measured by this technique in the range of primary neutron energies 0.8 to 1.5 Mev. (auth)

40061 CORE EXCITATION IN ^{65}Cu. J. Vervier (Centre d'Etude de l'Energie Nucléaire, Mol, Belg.). Nuovo Cimento (10), 28: 1412-26(June 16, 1963). (In English)

The model of Lawson and Uretsky for the energy levels of $_{29}Cu^{65}$ is improved by allowing a mixing of the $^3/_2^-$ ground state with the $^3/_2^-$ level arising from the coupling of the $p_{\frac{3}{2}}$ odd proton with the 2^+ first excited state of the even $_{28}Ni^{64}$ core. The model then contains 5 parameters which are calculated from 5 experimental data and used to predict

successfully other experimental results. Their values are shown to agree qualitatively with estimates of various nuclear models. Admixtures of shell model states other than the $p_{\frac{1}{2}}$ are considered. The energies of the first four excited levels can be accounted for by considering a vector-vector interaction between the odd proton and the core. The present model agrees with α-particle inelastic scattering experiments. Comparison is also made with neighboring nuclei. (auth)

40062 NEUTRINO-INDUCED REACTION IN ^{9}Be. V. de Sabbata and C. Gualdi (Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cimento (10), 28: 1484-90 (June 16, 1963). (In English)

A study was made of the $\nu + Be^9 \rightarrow p + e^- + Be^8$ reaction, with the possibility of using it as a detector for solar neutrinos. It was found that for neutrino energies above 0.878 Mev, such possibility exists; some peculiar cases are presented. (auth)

40063 MEASUREMENTS OF ELECTRON CASCADES IN COPPER AND LEAD AT ENERGIES UP TO 400 Mev. H. Lengeler (Technische Hochschule, Aachen), M. Deutschmann, and W. Tejessy. Nuovo Cimento (10), 28: 1501-3(June 16, 1963). (In English)

A systematic study was made of electron cascades by sending electrons of known energy into a propane bubble chamber that contained copper or lead plates. The purpose was to correlate measurement of track length of the cascades to electron energies. The resulting showers were compared with theoretical predictions. (R.E.U.)

40064 PAIRING ENERGIES IN SPHERICAL AND DEFORMED NUCLEI. G. Fano, J. Sawicki, and A. Tomasini (Università, Bologna and Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cimento (10), 29: 256-74(July 1, 1963). (In English)

An attempt is made to account for the observed pairing energies in several light spherical and deformed nuclei by using a simple B.C.S. plus Hartree-Fock model. As for the single-particle model, an isotropic harmonic oscillator potential was used for spherical nuclei, and an anisotropic one (Nilsson) for deformed nuclei. The basic interaction is assumed to be that of free nucleons, and two examples of the nucleon-nucleon potential are examined. The accuracy of the B.C.S. method for calculating the ground-state energy of the truncated Hamiltonian was proved to be quite good, but the resulting values of the theoretical pairing energies do not in general agree with the observed values. It is suggested that the most important reason for this discrepancy is given by the effect of the residual interaction between the quasi-particles. One possible method of estimating this effect is indicated. (auth)

40065 INTERFERENCE BETWEEN COULOMB EXCITATION AND RESONANCE INELASTIC SCATTERING IN ^{23}Na + p. A. S. Figuera, J. C. Armstrong, and J. B. Marion (Univ. of Maryland, College Park). Nuovo Cimento (10), 29: 281-4(July 1, 1963). (In English)

Coulomb excitation is investigated in the reaction $Na^{23}(p,p'\gamma)Na^{23}$. The competition of resonance inelastic scattering complicates the unambiguous identity of Coulomb excitation in the light-mass region. The 874-kev resonance in this reaction was considered, and the gamma spectrum was studied using targets of NaCl and NaOH. (R.E.U.)

40066 K_{e5} DECAY-MODE THROUGH VIRTUAL η-POLE APPROXIMATION. A. Gaffur (Middle East Technical Univ., Ankara). Nuovo Cimento (10), 29: 302-5(July 1, 1963). (In English)

A mechanism is proposed that would effectively explain the nature of the rare decay mode K_{e5}, in which K^+ will first be converted by $|\Delta I| = \frac{1}{2}$ weak interaction into a positron, neutrino, and a virtual meson (η). This virtual η-particle will in turn decay into $\pi^+ + \pi^- + \pi^0$. The experimental value of the rate of decay of K_{e5} is 4.17×10^6 sec^{-1}. (R.E.U.)

40067 ON THE DECAY SCHEME OF ^{47}Ca. E. Fuschini, V. Gadjokov, C. Maroni, and P. Veronesi (Università, Bologna). Nuovo Cimento (10), 29: 311-14(July 1, 1963). (In English)

As a preliminary measurement of an experimental test on time-reversal invariance in strong interactions, the mean lifetimes of the excited levels of Sc^{47} and the mixing ratio of the γ transitions were investigated. The decay scheme of Ca^{47} was studied in order to obtain information about the excited levels of its daughter product, Sc^{47}. (R.E.U.)

40068 PROTON EXCITATION OF TWO-PHONON LEVELS. J. M. Dickens, F. G. Perey, R. J. Silva, and T. Tamura (Oak Ridge National Lab., Tenn.). Phys. Letters, 6: 53-6(Aug. 15, 1963). (In English)

Proton inelastic scattering on Ni^{62} and Ni^{64} was investigated at 11 Mev. The differential scattering cross section and the differential cross section for the excitation of the one-phonon state and two-phonon triplet were presented. (C.E.S.)

40069 A MEASUREMENT OF THE LIFETIME OF THE 8.4 kev LEVEL IN Tm^{169}. T. Sunstroem, P. Sparrman, J. O. Lindstroem, and J. Lindskog (Uppsala Univ.). Phys. Letters, 6: 56-8(Aug. 15, 1963). (In English)

A delayed coincidence measurement of the lifetime of the 8.4-kev level in Tm^{169} is reported. A Yb^{169} sample that decays by electron capture to Tm^{169} was used. The decay scheme and conversion electron spectrum of the ground state decay of Yb^{196} are illustrated. The half life of the 8.4-kev level in Tm^{169} was found to be 3.45 ± 0.25 ns. (C.E.S.)

40070 THE REACTION $Ti^{46}(p,n)V^{46}(\beta^+)Ti^{46}$. J. Jaenecke (Florida State Univ., Tallahassee). Phys. Letters, 6: 69-72(Aug. 15, 1963). (In English)

The $Ti^{46}(p,n)V^{46}$ reaction and the subsequent β^+ decay of the odd and selfconjugate nucleus V^{46} were investigated at 8–10 Mev. Excitation curves obtained from the measurement of the intensity of the induced V^{46} activity were illustrated. From the ground state (p,n) threshold energy a Q-value of -7.844 ± 0.009 Mev and a maximum β^+ energy of 6.039 ± 0.009 Mev were calculated. The level scheme fo: Ti^{46} and a tentative level scheme including spin, parity, and isobaric spin assignments for V^{46} were presented. (C.E.S.)

40071 NEUTRON AND PROTON SCATTERING FROM THE SAME NUCLEUS AS A MEANS OF DETERMINING THE ISOSPIN TERM IN THE OPTICAL POTENTIAL. P. E. Hodgson (Nuclear Physics Lab., Oxford). Phys. Letters, 6: 75-6(Aug. 15, 1963). (In English)

A method for determining the isospin term of the optical potential by comparison of the optical potentials found from analyses of neutron and proton scattering by the same nucleus at the same energy was presented. Calculations were made using previous data for 14.5-Mev neutrons and data obtained from 17.3-Mev protons elastically scattered by natural copper. Complications due to the energy difference between the two sets of measurements and to the mixture of isotopes in the target were resolved. Optical model analyses of the data were made and the values of the potentials were presented. (C.E.S.)

40072 APPLICATION OF THE PARTICLE-HOLE MODEL TO PHOTONUCLEAR REACTIONS IN C^{12}. E. Boeker and C. C. Jonker (Vrije Universiteit, Amsterdam). Phys. Letters, 6: 80-3(Aug. 15, 1963). (In English)

The particle-hole model is used to calculate decay widths into different channels and angular distributions of outgoing particles for the $C^{12}(\gamma,p)$ reaction. Partial decay widths for the 1^- and 2^+ levels in C^{12} are given. The angular distributions were calculated and it is shown that this method may provide a sensitive test to the wave functions of the highly excited states in atomic nuclei. (C.E.S.)

40073 THE $\Lambda-\Lambda$ INTERACTION IN THE $_{\Lambda\Lambda}Be^{10}$ HYPERNUCLEUS. A. Deloff (Inst. for Nuclear Research, Warsaw). Phys. Letters, 6: 83-5(Aug. 15, 1963). (In English)

The volume integral of the Λ-Λ potential in the $_{\Lambda\Lambda}Be^{10}$ hypernucleus is calculated. The calculation is based on the alpha particle model of $_{\Lambda\Lambda}Be^{10}$ in which the hypernucleus is assumed to consist of two alpha particles held together by two hyperons (Λ). (C.E.S.)

40074 MOMENTUM OF SIGMA-PION PAIRS FROM THE CAPTURE OF K-MESONS BY LIGHT NUCLEI. R. K. Adair (CERN, Geneva). Phys. Letters, 6: 86-7(Aug. 15, 1963). (In English)

An analysis of the capture of mesons (K^-) by C^{12} shows that, even in the absence of a resonant Σ-π interaction, the spectrum of the resultant momentum of the Σ-π system may very likely exhibit a peak at a momentum near 170 Mev/c with a width as small as 60 Mev/c. (C.E.S.)

40075 A SEARCH FOR H^4. B. M. Spicer (Univ. of Melbourne). Phys. Letters, 6: 88-9(Aug. 15, 1963). (In English)

An attempt to observe the β decay of H^4 following the reaction $Li^6(\gamma,2p)$ succeeded in producing only an upper limit to the reaction cross section and limits on the value of the half life of H^4, if it exists. The half life must be shorter than 5×10^{-3} sec or longer than 5×10^4 sec. (C.E.S.)

40076 THE HALF-LIFE OF THE 57 kev FIRST EXCITED STATE IN Pr^{143}. E. Bożek, A. Z. Hrynkiewicz, S. Ogaza, M. Rybicka, and J. Styczén (Inst. of Nuclear Physics, Krakow). Phys. Letters, 6: 89-90(Aug. 15, 1963). (In English)

The half life of the 57-kev level in Pr^{143} was measured. A transistorized fast-slow coincidence circuit with a time-to-pulse-height converter was used to measure the gamma-gamma cascade for $Ce(NO_3)_3$ dissolved in nitric acid and polycrystalline Ce_2O_3. The mean value obtained for the half life is 4.20 ± 0.07 nsec. (C.E.S.)

40077 WEIZSÄCKER'S FORMULA, PAIRING ENERGY AND SUPERFLUID MODEL OF NUCLEI. P. Brovetto (Istituto Nazionale di Fisica Nucleare, Turin), V. Canuto, and F. Chaos. Phys. Letters, 6: 91-3(Aug. 15, 1963). (In English)

A justification of the Fermi term for the pairing energy in the Weizsäcker semi-empirical mass formula is given. A superfluid model of nuclei is used, and it is shown that the pairing energies δN and δZ are separately equal to the energy gaps ΔN and ΔZ, respectively. Sn^{108}, Sn^{116}, and Sn^{124}, which have a magic number of protons, are used as examples. (C.E.S.)

40078 ESTIMATION OF NUCLEAR DISTORTION FROM ISOTOPE SHIFT DATA. N. J. Ionesco-Pallas (Inst. of Atomic Physics, Bucharest). Phys. Letters, 6: 93-4(Aug. 15, 1963). (In English)

The correlation between isotopic constants in terms of neutron number and nuclear deformation is discussed. The derivative of the square of the nuclear deformation is plotted against neutron number for even-even nuclei $82 \leq A \leq 126$. The systematic variance of the parameter of axial distortion in the nuclear shell 82-126, which may be interpreted as confirming the statistical theory of nuclei, is illustrated. (C.E.S.)

40079 NEW NUCLEAR SPECIES Sc^{50m} AND Rh^{110}. M. Karras and J. Kantele (Univ. of Arkansas, Fayetteville). Phys. Letters, 6: 98-9(Aug. 15, 1963). (TID-19119) (In English)

Targets of Ti^{50} and Pd^{110} were bombarded with neutrons at 14-15 Mev in a search for activities of the isomeric state of Sc^{50} and the isotope Rh^{110}. The activities were found and information on the decay scheme and half life obtained was presented. (C.E.S.)

40080 NUCLEAR LEVEL PARAMETERS AND THE $Pb^{208}(\gamma,n)$ REACTION. W. Bertozzi, C. P. Sargent, and W. Turchinetz (Massachusetts Inst. of Tech., Cambridge). Phys. Letters, 6: 108-11(Aug. 15, 1963). (TID-19165). (In English)

The (γ,n) reaction is discussed as a method for obtaining data on the spin dependence of level spacings, the strength function for p and d-wave neutrons, and the distribution of partial radiation widths. The level parameters obtained for Pb^{208} are presented. (C.E.S.)

40081 TRUE STRONG COUPLING TREATMENT OF THE STRONGLY COUPLED CHANNEL THEORY OF THE NUCLEAR REACTIONS. Taro Tamura (Oak Ridge National Lab., Tenn.). Phys. Letters, 6: 111-13(Aug. 15, 1963). (In English)

It is shown that a strong coupling treatment can be developed with a slight modification of the theory based on the wave function of the total system in elastic and inelastic scattering. A possible application of this theory for the analysis of proton scattering on the well-deformed C^{12} nucleus is discussed. (C.E.S.)

40082 EXISTENCE OF H^4 AND Li^4. C. Werntz and J. G. Brennan (Catholic Univ. of America, Washington, D. C.). Phys. Letters, 6: 113-15(Aug. 15, 1963). (In English)

An argument favoring a choice of isobaric spin $T = 1$ for the 0^+ virtual state of He^4, which would correspond to the ground state of H^4 and Li^4, is presented. The binding energy and lifetime of H^4 and the excitation energy for Li^4 are estimated. (C.E.S.)

40083 NEGATIVE MUON CAPTURE RATES IN HIGH-Z ELEMENTS. T. A. Filippas, P. Palit, R. T. Siegel, and R. E. Welsh (Carnegie Inst. of Tech., Pittsburgh). Phys. Letters, 6: 118-20(Aug. 15, 1963). (In English)

A 70-Mev beam was used to obtain meson (μ^-) capture rates and lifetimes for nuclei $40 \leq Z \leq 70$. (C.E.S.)

40084 RADIATIVE MUON-CAPTURE IN COMPLEX NUCLEI. H. P. C. Rood and H. A. Tolhoek (Univ. of Groningen, Netherlands). Phys. Letters, 6: 121-2(Aug. 15, 1963). (In English)

Radiative meson (μ) capture in O^{16} and Ca^{40} is discussed. The photon spectra and the ratio of radiative capture to normal capture are presented. (C.E.S.)

40085 ANOMALOUS STATISTICS OF PARTIAL RADIATION WIDTHS. N. Rosenzweig (Argonne National Lab., Ill.). Phys. Letters, 6: 123-5(Aug. 15, 1963). (In English)

The existing statistical model was extended in order to describe the unexpectedly small fluctuations in the partial radiation widths that were reported for U^{239}. (C.E.S.)

40086 ENERGIES OF THE OCTUPOLE COLLECTIVE STATES OF EVEN-EVEN NUCLEI IN THE REGION $228 \leq A \leq 254$. V. G. Soloviev and P. Vogel (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 6: 126-8 (Aug. 15, 1963). (In English)

The energies of the octupole collective oscillations of even-even nuclei in the region $228 \leq A \leq 254$ are calculated in the framework of the superfluid nuclear model using the method of approximate second quantization. (C.E.S.)

40087 NUCLEAR POLARISATION OF Mn^{54} IN NICKEL. J. A. Cameron, R. A. G. Lines, B. G. Turrell, and P. J. Wilson (Clarendon Lab., Oxford). Phys. Letters, 6: 167-8 (Sept. 1, 1963). (In English)

The gamma ray anisotropies from Mn^{54} nuclei polarized in Ni were measured at several sample temperatures, and the corresponding values for the hyperfine field in Mn were calculated. The final corrected value for the field is 295 ± 5 kgauss, compared to 146 ± 5 kgauss for Mn in Fe. (D.C.W.)

40088 VELOCITY-DEPENDENT NUCLEON-NUCLEON POTENTIALS AND SATURATION IN NUCLEAR MATTER. M. A. Preston and R. K. Bhaduri (McMaster Univ., Hamilton, Can.). Phys. Letters, 6: 193-6(Sept. 1, 1963). (In English)

Nuclear matter calculations by Scott with a standard hard-core potential gave saturation at $k_F = 1.4$ fm^{-1}, while Green's calculations with a velocity-dependent potential gave no saturation even up to $k_F = 1.8$ fm^{-1}. Both potentials had the same two-body scattering data. The reasons for the discrepancy are examined, and a modification of Green's model potential that gives saturation at a reasonable value of density in nuclear matter is proposed. (D.C.W.)

40089 FLUCTUATIONS IN THE TOTAL CROSS SECTION OF THE REACTION $Al^{27}(n,\alpha)Na^{24}$. N. Cindro, P. Kulišič, and P. Strohal (Institute "Ruder Bošković," Zagreb). Phys. Letters, 6: 205-6(Sept. 1, 1963). (In English)

The relative cross sections were measured as a function of neutron energies from 14.13 to 14.78 Mev. Four distinct fluctuations were observed with an average period of 130 kev, corresponding to a half life of the compound nucleus of 0.5×10^{-20} sec. The half life for alpha emission of the compound nucleus at 21.6-Mev excitation energy was calculated to be 12×10^{-20} sec. The average amplitude of the fluctuations was 0.05 ± 0.01, somewhat less than a theoretical value. (D.C.W.)

40090 ANGULAR DISTRIBUTIONS AND STUDIES OF FLUCTUATIONS IN THE REACTION $Al^{27}(d,\alpha)Mg^{25}$ AT 10 Mev INCIDENT ENERGY. Y. Cassagnou, I. Iori, C. Levi, T. Mayer-Kuckuk, M. Mermaz, and L. Papineau (Commissariat à l'Energie Atomique, Saclay, France). Phys. Letters, 6: 209-12(Sept. 1, 1963). (In French)

Angular distributions and excitation functions of alpha particle groups leading to the lower levels of Mg^{25} were measured. A correlation function relating fluctuations in the excitation functions for the groups was calculated. The results do not exclude a direct interaction contribution in the reactions nor do they confirm or deny the existence of Ericson's fluctuations. (D.C.W.)

40091 (γ,n) CROSS SECTIONS FOR O^{16} AND Si^{28}. J. T. Caldwell, R. R. Harvey, R. L. Bramblett, and S. C. Fultz (Univ. of California, Livermore). Phys. Letters, 6: 213-16 (Sept. 1, 1963). (UCRL-7424). (In English)

The photoneutron cross sections were measured using nearly monochromatic photons obtained from the annihilation-in-flight of fast positrons and a 4π paraffin-moderated neutron counter. The energy levels and fractional dipole strengths were determined. Previously unreported levels appeared in the O^{16} data, while no (γ,2n) cross section was observed for either nuclide up to 30 Mev. The measured dipole strengths for O^{16} disagree with theoretical values. (D.C.W.)

40092 ANGULAR CORRELATIONS FOR THE PION PHOTOPRODUCTION ON He^4. E. Lohrmann, H. Meyer, and H. O. Wuester (Deutsches Elektronen Synchrotron, Hamburg). Phys. Letters, 6: 216(Sept. 1, 1963). (In English)

The application of calculated angular correlations arising from momentum conservation for secondary particles produced in high-energy collisions to $\gamma + He^4 \rightarrow He^3 + n + \pi^+$ interactions shows that momentum conservation has a great effect on angular correlations. For the case treated its effect was that of a $(n - H^3)$ bound state. (D.C.W.)

40093 THE HALF-LIFE OF THE 8.4 kev LEVEL IN Tm^{169}. R. E. McAdams, G. W. Eakins, and E. N. Hatch (Ames Lab., Ames, Iowa). Phys. Letters, 6: 219-22 (Sept. 1, 1963). (IS-710). (In English)

Electrons from transitions feeding the 8.4-kev level in Er^{169} and Yb^{169} decay were detected with an intermediate-image β-spectrometer. The M- or N-electrons de-exciting the level were detected similarly. From coincidences observed between the two groups of electrons, the half life was determined (from the combined Er^{169} and Yb^{169} data) to be 4.36 ± 0.17 nsec. (D.C.W.)

40094 EXCITATION OF THE SO-CALLED "TWO PHONON" STATE IN Fe^{56}, Fe^{58}, Ni^{62}, AND Ni^{64} BY INELASTIC SCATTERING OF α PARTICLES AT 44 Mev. M. Barloutaud-Crut, G. Bruge, J. C. Faivre, H. Faraggi, and J. Saudinos (Centre d'Etudes Nucléaires, Saclay, France). Phys. Letters, 6: 222-5(Sept. 1, 1963). (In French)

The angular distributions of the alpha particles emitted in the relatively weak excitation of Fe^{56}, Fe^{58}, Ni^{62}, and Ni^{64} levels located in the region of the triplet (0^+ 2^+ 4^+) of quadrupolar vibration of two phonons were measured. The distributions were analyzed by Blair's inelastic scattering model. The levels excited are discussed, and the distributions and excitation cross sections are compared with theoretical values. (D.C.W.)

40095 LIGHT ELEMENT PHOTONEUTRON PRODUCTION IN THE 0-80 Mev ENERGY RANGE. S. Costa (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin), F. Ferrero, S. Ferroni, B. Minetti, C. Molino, and R. Malvano. Phys. Letters, 6: 226-8(Sept. 1, 1963). (In English)

Differential and integrated cross sections for photoneutron production from several elements from Li^6 to Ca^{40} were obtained. The gamma absorption cross section and a ground state expectation value were evaluated. (D.C.W.)

40096 EXPERIMENTAL RESULTS ON THE (n,d) REACTION IN OXYGEN. E. Gadioli and S. Micheletti (Università, Milan). Phys. Letters, 6: 229-30(Sept. 1, 1963). (In English)

The angular distribution of deuterons from the reaction $O^{16}(n,d)N^{15}$ (ground state) at 14 Mev was measured. The angular distribution was fitted rather well by Bulter's plane-wave formula with $r_0 = 5$ and the angular momentum transfer $l = 1$. The l-value agrees with known spins and parities of the O^{16} and O^{15} ground states. (D.C.W.)

40097 THE DECAY OF Mg^{27}. T. R. Ophel and B. T. Lawergren (Australian National Univ., Canberra). Phys. Letters, 6: 230-1(Sept. 1, 1963). (In English)

Two NaI detectors were used to observe γ-γ coincidences in Mg^{27} decay. No evidence for the 0.84–0.81 and 0.84–1.01-Mev cascades reported by Ciufolotti and Demichelis as evidence for 1.65 and 1.83-Mev levels in Al^{27} was obtained. (D.C.W.)

40098 AN 8^+ STATE IN Si^{28}. A. R. Quinton and G. P. Lawrence (Australian National Univ., Canberra). Phys. Letters, 6: 231-2(Sept. 1, 1963). (In English)

The system Si^{28} formed in the course of $Al^{27}(p,\alpha)Mg^{24}$ and in $C^{12}(O^{16},\alpha)Mg^{24}$ was studied. The existence of a 13.70-Mev resonance in the O^{16} elastic scattering was confirmed, and the angular distribution of the ground state alpha particles indicates that an 8^+ state in the compound system is responsible for these decay alphas. The results for the (p,α) reaction indicate a complicated reaction mechanism and show that the Si^{28} compound system can be studied with little discrimination by this process. (D.C.W.)

40099 DYNAMIC POLARIZATION BY THERMAL MIXING BETWEEN TWO SPIN SYSTEMS. M. Goldman and A. Landesman (Centre d'Etudes Nucleaires, Saclay, France). Phys. Rev., 132: 610-20(Oct. 15, 1963).

A new dynamic nuclear polarization method is described, producing polarizations larger than the maximum polarization arising from a solid effect. The main effect is a cooling of a spin system I in zero applied or effective field, where its hamiltonian consists of its dipolar spin-spin interactions only; this cooling is followed by an adiabatic magnetization that produces the polarization. The cooling of the spin system I results from its thermal mixing with a second spin system S, having a large quadrupole interaction. Two types of experiments are considered: In zero applied field the thermal mixing is achieved in a frame rotating with respect to spins S and fixed with respect to spins I, by irradiating the sample with an r-f field of frequency close to the quadrupole frequency of the spins S. When a d-c field is applied, the mixing takes place in a frame rotating at different frequencies with respect to spins I and S, by using two r-f fields of frequencies close, respectively, to the resonance frequency of each spin system. The theory is based entirely upon the concept of spin temperature, both in laboratory and rotating frames. Experiments performed on paradichlorobenzene confirm the main features of the theory and provide a further verification of the spin-temperature hypothesis. A maximum proton polarization eight times larger than the polarization arising from a full solid effect was obtained. (auth)

40100 RANGES OF 5- TO 27-kev DEUTERONS IN ALUMINUM, COPPER, AND GOLD. R. L. Hines (Northwestern Univ., Evanston, Ill.). Phys. Rev., 132: 701-6 (Oct. 15, 1963).

A method of measuring ranges is presented that uses the change in optical-reflection coefficient of quartz due to radiation damage by the deuterons as a means of detecting the deuterons. The metal films are deposited on the quartz by vacuum evaporation and their thickness is determined with an accuracy of ±5% by weighing. By bombarding a given metal film on quartz at a fixed flux and a number of different energies, a number of bombarded areas are formed where the deuterons have penetrated to a corresponding number of different depths in the quartz. After chemically removing the metal film, the optical-reflection coefficients of the bombarded areas are measured and compared with theoretical predictions to determine the bombarding energy for which exactly one-half of the incident deuterons have penetrated the metal films. The ranges obtained agree with theoretical estimates and are consistent with known ranges of protons in aluminum. (auth)

40101 HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF PROMETHIUM-147 AND PROMETHIUM-151. Burton Budick and Richard Marrus (Univ. of California, Berkeley). Phys. Rev., 132: 723-8(Oct. 15, 1963). (UCRL-10375)

The atomic-beam magnetic-resonance method was used to measure the hyperfine structure of the $^6H_{\frac{5}{2}}$ level in two promethium isotopes. The spins of these isotopes were verified to be $I(Pm^{147}) = 7/2$ and $I(Pm^{151}) = 5/2$. The electronic splitting factor (g_J) was measured for the $^6H_{\frac{5}{2}}$ level and is found to be $g_J = -0.8279(4)$, in good agreement with the predicted value. The hyperfine constants and the nuclear moments inferred from them are presented. The nuclear moments are corrected for the breakdown of Russell-Saunders coupling. The stated errors include uncertainties in the fields at the nucleus arising from errors in the value of $\langle 1/r^3 \rangle$ and the neglect of core polarization on the magnetic hyperfine structure. Corrections due to the Sternheimer effect were not included. The measurements are shown to be consistent with the hypothesis that Pm^{147} is not highly deformed and can be understood from the shell model, but that Pm^{151} is highly deformed and must be interpreted by the collective model. (auth)

40102 MEASUREMENT OF THE TRIPLE-SCATTERING PARAMETER A IN PROTON-PROTON AND PROTON-CARBON SCATTERING AT 139 Mev. Stanley Hee and E. H. Thorndike (Harvard Univ., Cambridge, Mass.). Phys. Rev., 132: 744-9(Oct. 15, 1963).

The proton-proton triple-scattering parameter A was measured at a laboratory energy of 139 Mev over a range of scattering angles θ_2. The following values were obtained: θ_2(lab) = 15°, -0.368 ± 0.032; 20°, -0.344 ± 0.031; 25°, -0.311 ± 0.035; 30°, -0.231 ± 0.046; 35°, -0.187 ± 0.056; 40°, -0.099 ± 0.079. The parameter was also determined for p-carbon scattering at θ_2(lab) = 15° with a laboratory scattering energy of $138\frac{1}{2}$ Mev. The value obtained was -0.531 ± 0.048. The measurements are subject to a systematic error that could shift all values of A up or down together by perhaps 4%. In the errors listed above, this systematic error was combined quadratically with the other errors, which are of a nonsystematic nature. (auth)

40103 NEUTRON PHOTOPRODUCTION CROSS SECTION OF CALCIUM. K. Min, L. N. Bolen, and W. D. Whitehead (Univ. of Virginia, Charlottesville). Phys. Rev., 132: 749-51(Oct. 15, 1963).

The photoneutron cross section of natural calcium was measured from 15 to 30 Mev using the bremsstrahlung from the electron synchrotron. The neutron yields, measured in 0.5-Mev intervals, were used to unfold the photoneutron cross sections both in 1 and 0.5-Mev intervals. The cross section, which reaches the maximum value of 16.8 mb at 20.25 Mev, exhibits considerable structure. Below 21 Mev, it was possible to fit the data to the superposition of four discrete resonance curves of the Gaussian form, $\sigma = \sigma_0 \exp\{-[(E_0 - E)/\Delta]^2\}$, where σ_0 is the maximum cross section at energy E_0, and the parameter, Δ, is related to the full width at half maximum, Γ, by $\Gamma = 2(\ln 2)^{1/2}\Delta = 1.67\Delta$. The results are compared with the available shell-model calculations. (auth)

40104 DEUTERON OPTICAL-MODEL ANALYSIS IN THE RANGE OF 11 TO 27 Mev. C. M. Perey and F. G. Perey (Oak Ridge National Lab., Tenn.). Phys. Rev., 132: 755-73(Oct. 15, 1963).

Deuteron elastic scattering angular distributions are

analyzed using a simple optical model without spin-orbit potentials. Discrete valleys in the parameter space of the model are found to give a very good description of the data. Two of these regions are used to analyze 52 angular distributions measured for target nuclei with $Z \geq 12$ and deuteron energies in the range of 11 to 27 Mev, with particular emphasis on data at energies of 11.8, 15, and 21.6 Mev. In order to determine the trends of the optical-model parameters as a function of mass number and energy, four different sets of geometrical parameters are used, and only the well depths, real and imaginary, are varied to obtain a best fit to the experimental data. The real well depths show a smooth linear increase as a function of the Coulomb parameter $Z/A^{\frac{1}{3}}$ and a smoth linear decrease as a function of energy. The imaginary well depths show fairly large fluctuations from element to element but no systematic trend as a function of mass number. For all four sets of parameters, the imaginary well depth decreases rapidly for bombarding energies from 11 to 14 Mev and then increases slowly for energies from 15 to 27 Mev. (auth)

40105 DIFFUSENESS OF THE NUCLEAR SURFACE FROM S-WAVE STRENGTH FUNCTIONS. A. P. Jain (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 774-5(Oct. 15, 1963). (BNL-6901)

The S-wave strength function data are analyzed to find the diffuseness for the nuclei near 3S and 4S strength function giant resonances. The calculations are performed as a function of atomic weight, using a deformed optical model potential for two values of the diffuseness parameter a in the Saxon-Woods potential, a = 0.52 F and a = 0.30 F. The comparison of the data with the calculations indicates the value of a to be (0.5 ± 0.1) F, for the nuclei of both the 3S and 4S giant resonances. The result for the 4S giant resonance is in disagreement with that of Vogt. The reason for the disagreement is discussed. (auth)

40106 MAGNETIC PAIR SPECTROMETER STUDIES OF ELECTROMAGNETIC TRANSITIONS IN Be^{10} AND B^{10}. E. K. Warburton, D. E. Alburger, and D. H. Wilkinson (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 776-89(Oct. 15, 1963). (BNL-7044)

An intermediate-image pair spectrometer was used to study electromagnetic transitions in Be^{10} and B^{10}. Energy levels in these nuclei were populated by means of the $Be^9(d,p)Be^{10}$ and $Be^9(d,n)B^{10}$ reactions with deuteron energies between 2.0 and 3.2 Mev. In Be^{10} the branching ratios of the 5.96 → 0 and 5.96 → 3.37 transitions were determined to be 48 ± 2% and 52 ± 2%, respectively. A pair line corresponding to the 6.26 → 3.37 transition was observed and an upper limit of 0.4% was placed on the relative intensity of the 6.26 → 0 transition which supports an assignment of 2^- for the Be^{10} 6.26-Mev level. In addition, a 6.18 → 0 transition was observed but not a 6.18 → 3.37 transition. The energy difference between the 6.18 → 0 pair line and the 5.96 → 0 pair line was measured with sufficient accuracy to show that the Be^{10} 6.18-Mev level has a mean lifetime greater than 5×10^{-13} sec, and consequently has a most probable spin-parity assignment of 0^+. In B^{10} the relative intensities of the 3.58 → 0.72 and 3.58 → 0 transitions were found to be (4.2 ± 0.3) : 1 if both transitions are M1 while the branching ratios of the 5.16 → 2.15, 5.16 → 0.72, and 5.16 → 0 transitions were found to be (65 ± 2)%, (29.5 ± 2)%, and (5.5 ± 0.7)%, respectively. Transitions from the B^{10} 4.77-Mev level were not observed and a limit of $\Gamma_\gamma/\Gamma < 0.05$ was set for this α-particle unbound level. Data are presented to enable Γ_γ/Γ for the 5.16-Mev level of B^{10} to be computed when the relative production cross sections of that state and the 3.37-Mev state of Be^{10} in deuteron bombardments become known. In order to obtain these results, calculations of the spectrometer pair-line efficiency were extended to include the emission of internal pairs from aligned nuclei. The experimental results are compared to the predictions of the independent-particle model. (auth)

40107 MAGNETIC PAIR SPECTROMETER STUDIES OF ELECTROMAGNETIC TRANSITIONS IN C^{14} AND N^{14}. D. E. Alburger and E. K. Warburton (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 790-6(Oct. 15, 1963). (BNL-6904)

An intermediate-image pair spectrometer was used to study electromagnetic transitions in C^{14} and N^{14}. Energy levels in these nuclei were populated by means of the $C^{13}(d,p)C^{14}$ and $C^{13}(d,n)N^{14}$ reactions with deuteron energies between 1.9 and 3.1 Mev. In C^{14} a 6.58-Mev transition was observed in the internal pair spectrum but not in the external pair spectrum. From this a definite assignment of $J^\pi = 0^+$ can be made for the C^{14} 6.58-Mev level. In N^{14} the branching ratios of the 5.69 → 0 and 5.69 → 2.31 transitions were determined to be 37 ± 2%, respectively. The energy differences between close-lying pair lines were measured with sufficient accuracy to allow limits to be placed on the lifetimes of some states in C^{14} and N^{14}. Thus, it was determined that the mean lifetime of the C^{14} 6.58-Mev level is greater than 4×10^{-13} sec. (auth)

40108 NEUTRON CAPTURE IN IRON. J. A. Moore, H. Palevsky, and R. E. Chrien (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 801-6(Oct. 15, 1963). (BNL-7088)

A search for resonances responsible for neutron capture in iron below 3 kev was made with fast choppers. Capture area, self-indication, and transmission techniques were employed. The only resonance observed was that at 1200 ev. The complete set of parameters for the resonance was derived: E_0 = 1200 ± 30 ev, σ_0 = 165 ± 12 b, Γ_γ = 0.673 ± 0.074 ev, and Γ_n = 0.056 ± 0.06 ev. Analysis of the capture gamma-ray spectrum shows the resonance to be due to Fe^{56} and establishes the compound state as $\frac{1}{2}^+$. The variation of total cross section with energy from 0 to 3 kev is ascribed to a neutron bound level with the following parameters: E_0 = 4390 ± 1700 ev, Γ_n^0 = 12.5 ± 8.1 ev, R' = 3.9 F, and Γ_γ = 1.02 ± 0.46 ev. It is demonstrated that the previously measured resonance capture integral of Fe cannot be accounted for in terms of known resonances. (auth)

40109 GAMMA-RAY ANGULAR CORRELATIONS AND SPIN ASSIGNMENTS IN Sm^{149}. O. K. Harling (General Electric Co., Richland, Wash.), C. A. Ventrice, and J. J. Pinajian. Phys. Rev., 132: 807-12(Oct. 15, 1963). (HW-SA-3058).

Levels in Sm^{149}, following electron-capture decay from Eu^{149}, occur at 22.5, 277, 350, 529, and 558 kev. Experimentally determined coefficients of the correlation function are $A_2 = -0.398 \pm 0.040$, $A_4 = 0.122 \pm 0.024$; $A_2 = -0.139 \pm 0.018$, $A_4 = 0.218 \pm 0.065$; and $A_2 = 0.147 \pm 0.022$. $A_4 = -0.267 \pm 0.080$, respectively, for the following gamma cascades: 180–328, 281–277, and 73–277 kev. Assuming a mixture of dipole and quadrupole radiation for all of the cascading gamma rays, the theoretical coefficients were calculated and compared with the experimental results. Spin assignments for the excited states in Sm^{149}, which are consistent with the experimental results, are $\frac{7}{2}$ (22.5 kev), $\frac{9}{2}$ (277 kev), $\frac{9}{2}$ (350 kev), $\frac{7}{2}$ or $\frac{11}{2}$ (529 kev), and $\frac{7}{2}$ (558 kev). The quadrupole-dipole mixing was determined for

the cascading gamma rays. The half-life of the isotope associated with the 281- – 277-kev coincidence was measured in order to reduce the uncertainty of assigning the 281-kev gamma ray. (auth)

40110 (p,d) NUCLEAR STRUCTURE STUDIES ON NUCLEI BETWEEN A = 12 AND A = 48. C. D. Kavaloski, G. Bassani, and Norton M. Hintz (Univ. of Minnesota, Minneapolis). Phys. Rev., 132: 813-22(Oct. 15, 1963).

A 40-Mev proton beam was used to study a number of medium-mass nuclei via the single-neutron pickup reaction. Elements studied were C^{12}, O^{16}, $Mg^{24,25,26}$, $S^{32,34}$, Ca^{40}, and Ti^{48}. Deuteron energy spectra were taken over a range generally corresponding to 5 or 10 Mev of excitation of the final nucleus. Angular distributions were taken over a range from 6 to 60° for most of the well-defined deuteron groups. Reduced widths were extracted using the Butler theory. The $d_{\frac{5}{2}} - s_{\frac{1}{2}}$ and $d_{\frac{3}{2}} - d_{\frac{5}{2}}$ hole-energy differences in Ca^{39} were found to be 2.6 ± 0.15 and 6.3 ± 0.15 Mev, respectively. The $p_{\frac{1}{2}} - p_{\frac{3}{2}}$ difference in O^{15} was measured to be 6.4 ± 0.15 Mev. (auth)

40111 NUCLEAR SIZE EFFECT ON BREMSSTRAHLUNG IN THE Bev RANGE. B. J. Malenka and H. P. Smith (Northeastern Univ., Boston). Phys. Rev., 132: 863-6(Oct. 15, 1963).

Since a more detailed knowledge of the bremsstrahlung cross section at high energies may be required for certain photoproduction experiments, the percentage correction to the Bethe-Heitler point-nucleus results arising from the finite size of the nuclear-charge distribution is estimated. The effect of a shape-independent approximation to the form factor is considered. The results presented indicate corrections of less than a few percent for incident electrons with energies in the Bev range. A comparison with previous work is also made. (auth)

40112 EXPECTATION VALUE FLUCTUATIONS IN THE UNITARY ENSEMBLE. Nazakat Ullah and Charles E. Porter (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 948-50(Oct. 15, 1963). (BNL-7052)

The random matrix hypothesis is used to derive the expectation value fluctuations for systems that violate time-reversal symmetry. A general expression is derived for the even moments of a complex direction cosine in an N-dimensional unitary space. It is shown that the second and third moments about the mean of the gyromagnetic ratio for the unitary case are obtained from those for the othogonal ensemble by replacing the dimension N by 2N in the case of large dimension. (auth)

40113 AXIALLY ASYMMETRIC DEFORMATION AND ITS STABILITY IN sd-SHELL NUCLEI. Kenjiro Takada (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 30: 60-70 (July 1963). (In English)

The magnitude of nuclear deformation and its asymmetry are determined by the variational method in the cases of Ne^{20}, Ne^{22}, and Mg^{24}. The hamiltonian used in this work is essentially the same with that in Brueckner's single particle model space, where the reaction matrix is calculated from the Gammel-Thaler potential. The wave function in an ellipsoidal potential is taken as a trial wave function, in which parameters of deformation and asymmetry are taken as variational parameters. The energy surfaces thus obtained show that the deformation of Ne^{20} and Ne^{22} is axially symmetric and large and Mg^{24} has an asymmetric large deformation. The stability of asymmetry of Mg^{24} in the ground state is examined by solving the Bohr hamiltonian. The energy surface is taken as a potential of the collective motion. Result is that the asymmetry of Mg^{24} is fairly large but the wave function of γ-vibration is hardly localized. This is inconsistent with Davydov's basic concept. (auth)

40114 LIGHT DOUBLE HYPER NUCLEI AND Λ-Λ INTERACTION. Hiroshi Nakamura (Tokyo Inst. of Tech.). Progr. Theoret. Phys. (Kyoto), 30: 84-95(July 1963). (In English)

The relation between the bound states of light double hypernuclei with mass number 3, 4, 5, and 6 and the Λ-Λ interaction is analyzed by a simple variational method. It is strongly indicated that unless the Λ-Λ force is very strong $_{\Lambda\Lambda}H^3$ and $_{\Lambda\Lambda}n^3$ do not exist because the N-Λ force is too weak in these systems, and that the well-depth parameter of the Λ-Λ interaction must be $\gtrsim 0.8$ to allow the bound state $_{\Lambda\Lambda}H^4$. These conclusions were obtained on the assumption of a central Λ-Λ interaction of a Yukawa shape with range parameter $(2m_\pi)^{-1}$ (m_π: π-meson mass). (auth)

40115 QUASI-FREE PROTON-PROTON SCATTERING FROM Ca^{40} AT 180 Mev. Il-Tong Cheon (Kyoto Univ.), Nobuo Kawamura, and Toshinori Takemiya. Progr. Theoret. Phys. (Kyoto), 30: 136-7(July 1963). (In English)

Experimental results of quasi-free proton scattering on Ca^{40} at 180 Mev were compared with theoretical results calculated by means of the single particle picture for Ca^{40}. A solution obtained from the harmonic oscillator potential with Thomas type spin-orbit coupling for the initial wave function of the protons to be knocked out in the final state and the plane waves for the incoming and outgoing protons is used. It is assumed that the (p,2p) reaction takes place in the surface region. Angular distributions were presented for the $5_{\frac{1}{2}}$, $d_{\frac{5}{2}}$, and $d_{\frac{3}{2}}$ proton groups. (C.E.S.)

40116 ON THE EFFECTIVE RANGE OF THE RESIDUAL POTENTIAL IN THE SHELL MODEL. Sinobu Nagata and Yutaka Nishibori (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 30: 140-2(July 1963). (In English)

In order to discuss the effective range of the residual potential in the shell model the elements of the reaction matrix that are related directly to the level spacing in the case of two particles in the open shell are investigated. Results are illustrated for Ca^{42} and Al^{26}. It is shown that the effective range of the reaction matrix, which has the attractive part with short range, is very long and nearly equal to those of well-behaved central potentials in the shell model. (C.E.S.)

40117 PHOTODISINTEGRATION OF LIGHT NUCLEI. Evans Hayward (National Bureau of Standards, Washington, D. C.). Rev. Mod. Phys., 35: 324-31(Apr. 1963).

The main features of the electric-dipole-absorption cross section for light nuclei are clarified as a result of new experimental techniques in the study of the nuclear photoeffect. In general, this cross section is characterized by a broad maximum, designated as the giant resonance, located at an energy of 12 to 20 Mev depending on the nucleus under consideration. (R.E.U.)

40118 LOCATION OF NEUTRON SINGLE-PARTICLE LEVELS FROM STRIPPING REACTIONS. B. L. Cohen, R. H. Fulmer, A. L. McCarthy, and P. Mukherjee (Univ. of Pittsburgh). Rev. Mod. Phys., 35: 332-4(Apr. 1963).

A stripping process, for example (d,p), is extremely useful in the study of the single-particle states of the nuclear shell model. Two of the simplest experimental measurements, the cross sections for excitation of the various states of the final nucleus and the angular distributions of the proton groups corresponding to these states, give essentially all of the pertinent information. (R.E.U.)

40119 ROTATIONAL AND SINGLE-PARTICLE EXCITATIONS OF NONSPHERICAL ODD ATOMIC NUCLEI. A. S. Davydov (Kiev Inst. of Physics). Ukr. Fiz. Zh., 8: 717-27(July 1963). (In Ukrainian)

The energy levels and probabilities of electromagnetic transitions were investigated in odd atomic nuclei. It is shown that in odd nuclei small excitations cannot be divided into rotational and single-particle excitations. General expressions are obtained for the numerical computation of the energy states of various nuclei. (auth)

40120 ON THE EFFECT OF NONLOCAL INTERACTION BETWEEN NUCLEONS ON THE PHOTOEFFECT CROSS-SECTION. A. G. Sitenko and O. V. Drobachenko (Khar'kov State Univ. and Khar'kov Aviation Inst.). Ukr. Fiz. Zh., 8: 728-32(July 1963). (In Ukrainian)

It is shown that nonlocal interaction between nucleons in the nucleus leads to an increase in the integral cross section of dipole photoabsorption, irrespective of the presence of exchange forces. Yamaguchi's nonlocal potential is used in the calculation. (auth)

40121 RECENT RESEARCH ON BETA-DISINTEGRATION. A. I. Alikhanov. Translated from the Russian by William E. Jones. International Series of Monographs on Nuclear Energy. Division II. Nuclear Physics. Volume 12. A Pergamon Press Book. New York, The Macmillan Company, 1963. 155p. $3.00.

Results of beta disintegration experiments that are connected with the discovery of non-conservation of parity in weak interactions are presented. Other topics include asymmetric emission of electrons in the beta disintegration of oriented nuclei, longitudinal polarization of beta-electrons, parity violation, types of beta interaction, value of beta interaction constants, capture of antineutrino by a proton, and double beta disintegration. (C.E.S.)

40122 NUCLEAR PHYSICS. PROCEEDINGS OF THE INTERNATIONAL SCHOOL OF PHYSICS "ENRICO FERMI." COURSE XXIII. V. F. Weisskopf. New York, Academic Press, 1963. 192p. $7.50.

Lectures were presented on wave-function applications in nuclear physics. The topics discussed included the Hartree-Fock approximation, nuclear moments, collective motion and the application of many-body techniques, the compound nucleus and the random phase approximation, the spurious state in connection with β-vibration of nuclei, distribution of nuclear charge and magnetization from atomic hyperfine structure, effective interactions in deformed nuclei, and the interference of compound and direct processes. Separate abstracts are prepared for 8 of the 9 papers presented. The paper on the spurious state was previously abstracted in NSA (17: 5381). (C.E.S.)

40123 THE HARTREE-FOCK APPROXIMATION IN NUCLEAR PHYSICS. F. Villars (Massachusetts Inst. of Tech., Cambridge). p.1-47 of "Nuclear Physics." New York, Academic Press, 1963.

The Hartree-Fock approximation is applied to quantum mechanical matrix theory. The Hartree-Fock equations are given and their applications in the formalism of second quantization, the reaction matrix of singular forces, collective motion, and quasi-particles are developed. (C.E.S.)

40124 NUCLEAR MOMENTS. A. de-Shalit (Weizmann Inst. of Science, Rehovoth, Israel). p.48-62 of "Nuclear Physics." New York, Academic Press, 1963.

A nuclear wave function is analyzed and the properties that should be expected of a wave function that is an eigenfunction of the nuclear hamiltonian are investigated. Properties of the irreducible tensor operators and the form of interaction are considered. Moments determined from nuclear and magnetic dipole interactions are discussed. Multiple moments and their theoretical interpretations are also considered. It is concluded that the magnetic moment operator for complex nuclei has a relatively simple structure. (C.E.S.)

40125 NUCLEAR PHYSICS. C. Levinson (Weizmann Inst. of Science, Rehovoth, Israel). p.63-98 of "Nuclear Physics." New York, Academic Press, 1963.

Recent progress in the development of nuclear shell model techniques is discussed. It is shown that the shell-model wave functions for the ground and lower excited states for nuclei in the 1p, 2s and 1f, 2p shells are rather well described by a rotating independent particle wave function. Long and short-range forces, the generators of the group SU_3 of unitary transformations of dimension three with determinant unity, the normal-range shell model hamiltonian, matrix elements of particles in the 2s, 1d shell, deformation, and vibrations of an intrinsic state are also considered. (C.E.S.)

40126 COLLECTIVE MOTION AND THE APPLICATION OF MANY-BODY TECHNIQUES. G. E. Brown (NORDITA, Copenhagen). p.99-141 of "Nuclear Physics." New York, Academic Press, 1963.

Collective motion in nuclei is investigated by means of techniques previously applied in solid-state physics and in the electron gas. The vibrations of the closed shells in spherical nuclei, wave function spatial dependence, particle-hole and particle-particle interactions, the sum rule, octupole vibrations, even-parity states, dipole vibrations, Green's functions, Green's function calculation in perturbation theory, the extended schematic model, moment of inertia, and the construction of rotating solutions are discussed. (C.E.S.)

40127 THE COMPOUND NUCLEUS AND THE RANDOM PHASE APPROXIMATION. T. Ericson (CERN, Geneva). p.142-52 of "Nuclear Physics," New York, Academic Press, 1963.

Implications that follow from the definition of the compound nucleus reaction as a reaction for which formation and decay are independent and uncorrelated but for conservation of energy and angular momentum are discussed. It is shown that this independence hypothesis can only be valid as an average property of the compound system outside the energy region in which the width of resonances is small compared to the level distance in the intermediate nucleus. It is also shown that cross section fluctuations provide both the means of measuring the lifetime of very highly excited compound nuclei and the means of obtaining the compound elastic cross section outside the ordinary resonance region. A random phase approximation is assumed for the compound nucleus matrix elements for the width amplitude factor. (C.E.S.)

40128 DISTRIBUTION OF NUCLEAR CHARGE AND MAGNETIZATION FROM ATOMIC HYPERFINE STRUCTURE. H. H. Stroke (Massachusetts Inst. of Tech., Cambridge). p.156-66 of "Nuclear Physics." New York, Academic Press, 1963.

Isotope and isomer shifts and hyperfine structure are investigated to obtain information on the charge distribution and magnetic structure of the nucleus. These two types of studies are differentiated since the isotope shifts depend on the monopole part of the electron nuclear interaction, while

the hyperfine structure splittings result from the multipole interactions. In particular the hyperfine structure anomaly that reflects the change of the hyperfine structure interaction when the nucleus departs from a point to a finite distribution of nuclear magnetization is considered. (C.E.S.)

40129 EFFECTIVE INTERACTIONS IN DEFORMED NUCLEI. J. Unna (Weizmann Inst. of Science, Rehovoth, Israel). p.167-72 of "Nuclear Physics." New York, Academic Press, 1963.

Intermediate coupling analysis of the low lying energy levels in O^{17}, F^{18}, F^{19}, and Ne^{20} is presented. It is shown that the wave functions of the nuclear states are quite insensitive to the form of the two-body interaction. The calculated energies are sensitive to the two-body forces, and none of the simple nuclear forces can reproduce the experimental energies accurately enough. It is also shown that the effective deformation for states with maximum isospin is much smaller than that for states with lower isospins. (C.E.S.)

40130 THE INTERFERENCE OF COMPOUND AND DIRECT PROCESSES. J. E. Young (Universitet, Copenhagen). p.173-86 of "Nuclear Physics." New York, Academic Press, 1963.

An elastic scattering amplitude is derived to illustrate the interference between compound and direct nuclear reactions. Nuclear scattering is considered. An exact potential is used to provide distorted-wave motion for the added nucleon, and the inexact and smaller bound-state potential is used to compute the transition matrix element. (C.E.S.)

40131 CHARGE TRANSFER AND ION-ATOM INTERCHANGE COLLISIONS ABOVE THERMAL ENERGIES. Wade L. Fite (General Atomic Div., General Dynamics Corp., San Diego, Calif.). 44p. (CONF-228-1; GA-4506)

From International Association of Geomagnetism and Aeronomy 13th General Assembly of the International Union of Geodesy and Geophysics, Berkeley, Calif., Aug. 1963.

High-energy charge transfer and ion-atom interchange collisions are considered in support of aeronomy. High energy is considered to mean sufficiently high that a well-defined, effectively monoenergetic beam of selected ions is used in the experimental method, which generally implies ion energies of greater than a few electron volts. The experimental methods used to obtain the laboratory results are presented. The main purpose of the experiments is the determination of cross sections for the reactions involved. Consideration is given to detection of fast and slow particles and of excited states resulting from the reactions. (R.E.U.)

Particle Accelerators

Refer also to abstracts 38605, 39381, and 39416.

40132 (BNL-7204) MULTIPLE EXPERIMENTAL OPERATION AT THE AGS. R. R. Adams, E. B. Forsyth, W. Gefers, G. K. Green, H. J. Halama, A. W. Maschke, M. Plotkin, and J. Spiro (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 19p. (CONF-114-15)

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

The AGS systems that provide the precision beam control necessary for reliable beam sharing and the use of these systems to provide secondary beams for a recently completed program of five experiments are described. (auth)

40133 (BNL-7205) BEAM OBSERVATION AND MANIPULATION IN THE AGS. R. R. Adams, E. D. Courant, W. F. Gefers, G. K. Green, H. J. Halama, M. Plotkin, E. C. Raka, and J. Spiro (Brookhaven National Lab., Upton, N. Y.). [July 18, 1963]. Contract [AT(30-2)-Gen-16]. 18p. (CONF-114-16)

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

The electrostatic induction (pickup) electrode system used for beam observation at the alternating-gradient synchrotron is described; and betatron oscillation minimization, equilibrium orbit measurement, vertical orbit correction, beam intensity measurement, and frequency determination using these electrodes are described. The separately monitored set of electrodes (one for radial position and one for total beam deflection) that feeds the r-f system is also discussed. (D.C.W.)

40134 (BNL-7206) SOME CHARACTERISTICS OF THE AGS LINAC BEAM AND RELATED ION SOURCE STUDIES. A. van Steenbergen, L. W. Oleksiuk, and J. P. Blewett (Brookhaven National Lab., Upton, N. Y.). [July 18, 1963]. Contract [AT(30-2)-Gen-16]. 27p. (CONF-114-17).

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

Longitudinal phase space acceptance and transverse phase space properties were studied with the proton beam of the alternating-gradient synchrotron linac injector. This was done both with and without beam bunching preceding the linac. The experimentally observed beam acceptance agrees satisfactorily with theoretical expectation. Beam composition, transverse phase space area and phase space density distribution were investigated with the duoplasmatron ion source, utilizing beam currents in the range of 20 to 120 mamp. The emittance measurements were done at energy levels of 30-60 and 750 kev, respectively. The results are discussed and compared with some results obtained with a PIG ion source and a r-f ion source. (auth)

40135 (BNL-7208) NOTES ON COHERENT EFFECTS IN THE COSMOTRON. M. Q. Barton (Brookhaven National Lab., Upton, N. Y.). [July 17, 1963]. Contract AT (30-2)-Gen-16. 10p.

Experiments on the time dependence of intensity dependent losses indicated that the longitudinal instability caused a loss of particles from the Cosmotron after injection. Subsequent increases of the effective aperture of the device and of the intensity eliminated these intensity dependent losses during injection. Also, spreading the beam energy by use of appropriate r-f accelerating cavities resulted in reduction of the random growth that characterized the longitudinal instability, but an intensity independent bunching occurred. The stabilization was also much less effective than was theoretically expected. (D.C.W.)

40136 (BNL-7220) EXPERIMENTAL BEAMS AT THE BROOKHAVEN AGS. M. Hildred Blewett (Brookhaven National Lab., Upton, N. Y.). [July 18, 1963]. Contract [AT(30-2)-Gen-16]. 17p. (CONF-114-12)

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

The beams and beam handling equipment provided for two experimental areas at the Brookhaven Alternating-Gradient Synchrotron are described. Information on experiments, experimental apparatus, and provisions for certain experiments in these areas is included. (D.C.W.)

40137 (BNL-7221) PARTICLE DYNAMICS IN STORAGE RINGS. E. D. Courant (Brookhaven National Lab., Upton, N. Y.). [July 18, 1963]. Contract [AT(30-2)-Gen-16]. 10p. (CONF-114-10)

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

The limitations placed upon currents circulating in 25-30 and 300 Bev storage rings by phase space, space charge, and image force considerations are examined, and the experimental usefulness, of the beams obtainable subject to these considerations is discussed. (D.C.W.)

40138 (BNL-7228) ACCELERATOR DESIGN STUDIES FOR PRODUCTION OF HIGH CENTER-OF-MASS ENERGIES. J. P. Blewett (Brookhaven National Lab., Upton, N. Y.). [July 18, 1963]. Contract [AT(30-2)-Gen-16]. 13p. (CONF-114-11)

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

The problems associated with injecting high-intensity (up to 10^{15} protons/sec) high-energy proton beams into synchrotrons and accelerating them to very high energies (1000 Bev) are discussed. The results of a study on possible experimentation with super-high-energy accelerators and with storage rings are briefly reviewed. Coasting beam experiments performed on the AGS and the cosmotron to check theoretical predictions about coasting beams in storage rings are described. With the accelerated beams held at constant field, the beams were found to decay exponentially. No surprising instabilities appeared, and the results of the experiments are within a factor of two of the theoretical predictions. (D.C.W.)

40139 (BNL-7229) DESIGN AND PERFORMANCE OF BENDING AND QUADRUPOLE MAGNETS FOR THE AGS EXPERIMENTAL PROGRAM. M. H. Blewett and G. T. Danby (Brookhaven National Lab., Upton, N. Y.). [July 18, 1963]. Contract [AT(30-2)-Gen-16]. 20p. (CONF-114-13).

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

Considerations affecting the design of the deflecting and quadrupole magnets for the Brookhaven Alternating-Gradient Synchrotron are discussed, and the resultant designs, properties, and performance of the magnets are discussed. Results of measurements on the magnets are displayed. (D.C.W.)

40140 (BNL-7230) INTERNAL TARGET SYSTEM AND INDUCED RADIOACTIVITY AT THE AGS. J. Faust, C. Flatau, R. King, and I. Polk (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 40p. (CONF-114-9)

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

The requirements affecting the design of a target system for a large strong-focusing proton synchrotron are discussed, and the design and performance of the AGS system are described. The levels and origins of radiation (particularly radioactive isotope production) at this facility are also discussed, as are the attendant safety policies. (D.C.W.)

40141 (BNL-7280) AGS PERFORMANCE AND PLANS. G. K. Green (Brookhaven National Lab., Upton, N. Y.). [July 18, 1963]. Contract [AT(30-2)-Gen-16]. 12p. (CONF-114-14)

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

The experimental facilities and performance of the Alternating-Gradient Synchrotron are discussed. Additions and modifications to the accelerator and facilities presently underway are described, as well as future requirements of this nature. Problems of radioactivity and of providing higher momenta are also pointed out. (D.C.W.)

40142 (DESY-A2.100) DER INJEKTIONSWEG. (The Injection Process). W. Schmidt (Deutsches Elektronen-Synchrotron, Hamburg). June 21, 1963. 19p.

The elements and data that are necessary for injecting the electrons from the linear accelerator into the synchrotron are surveyed. Beam and energy matching, especially, are considered. A change in the location of the injection point, with respect to the linac position, required a recalculation of the beam path between the linear accelerator and the synchrotron. The revised beam geometry, with the exception of beam matching, is summarized. (auth)

40143 (NP-13102) REZONANSNAYA DEPOLYARIZATSIYA PUCHKA V PROTONNYKH SINKHROTRONAKH ITEF. (Resonance Depolarization in Proton Synchrotron ITEF). P. R. Zenkevich (Akademiya Nauk S.S.S.R. Institut Teoreticheskoi i Eksperimental'noi Fiziki and U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol' zovaniyu Atomnoi Energii). 1963. 15p.

The components of the depolarized magnetic field in a proton synchrotron with strong focusing are determined. The classical relativistic equation for the polarization vector as well as an approximate method for its solution are given. By this method the value of beam depolarization in the 7 and 70-Bev proton synchrotrons of ITEP is estimated. (auth)

40144 (NP-13152) DESIGN CONSIDERATIONS FOR A 0 TO 45 DEGREE BENDING MAGNET. A. C. Paul (California. Univ., Los Angeles). July 1963. Contract Nonr-233(44). 17p.

A magnet design that provides a maximum of flexibility for future changes in the external beam requirements is proposed. A pair of magnets of 4.5 inch aperture, permitting an angular bend continuously adjustable (by easily accomplished shimming) from 0 to 45° on a 30 inch radius of curvature is considered. This corresponds to a magnetic field of 13,500 gauss for 50 Mev protons. The magnets can either be used individually as beam switching magnets or together as a dispersionless beam transport system. (auth)

40145 (USNRDL-TR-667) RESIDUAL RADIOACTIVITY FOLLOWING CYCLOTRON SHUTDOWN. C. Sharp Cook (Naval Radiological Defense Lab., San Francisco, Calif.). Aug. 20, 1963. 40p. (AD-417577)

The physical interactions through which residual radioactivity can be developed in the shielding vault of the NRDL 70-inch AVF cyclotron are reviewed, and the design characteristics that affect the magnitude of the ultimate residual radiation field that will be found are discussed. By comparison with measurements at other cyclotrons, estimates of the expected maximum residual gamma-radiation fields are reported. From the results it appears that, under certain conditions of operation of the NRDL cyclotron, residual radiation fields after shutdown may possibly present a serious hazard, but it should be possible, through careful design of specific parts of the cyclotron, to keep the magnitude of this radiation below hazardous levels. (auth)

40146 (UCRL-10853) POWER SUPPLY FOR 7.5-MW PULSED LOAD. Ferd Voelker and George Farley (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 19, 1963. Contract W-7405-eng-48. 26p. (CONF-210-2)

From Pacific Annual Meeting, Spokane, Aug. 1963.

The conversion of a 12-phase high-powered mercury rectifier to supply energy to a pulsed load is described. Newly developed hard-tube switches and a shunted RC network are used in combination with the rectifier to replace the existing pulse-line energy storage and the associated charging system. The switch tubes will also serve as a regulating means to reduce ripple voltage during the pulse. Pulse durations of 2.5 to 5 msec are contemplated. The load will require 250 amps at 25 to 30 kv during the pulse. The pulse repetition rate will probably be 40/second, as this avoids unsymmetrical magnetization of the rectifier transformers. A low-powered test model was used to confirm the design parameters. (auth)

40147 (NP-tr-1062) COLLIDING BEAMS OF HIGH ENERGY PROTONS IN AN ACCELERATOR WITH NONLINEAR FOCUSING. Yu. F. Orlov. Translated by E. Fischer from p.318-36 of "Problems of Elementary Particle Physics" (a publication of Academy of Sciences, Armenian SSR). 1962. 36p.

The principles of nonlinear focusing and acceleration in a field with nonlinear focusing are examined, and the use of a nonlinear focusing accelerator for colliding beams is described. (D.C.W.)

40148 NEW WAYS OF INCREASING THE EFFICIENCY OF THE ELECTRON CYCLOTRON (MICROTRON). K. A. Belovintsev, A. Ya. Belyak, V. I. Gridasov, and P. A. Cherenkov. At. Energ. (USSR), 15: 62(July 1963). (In Russian)

The efficiency η of an electron cyclotron can be defined as the ratio of the useful power P_n required to accelerate the resonance electrons to the minimum power of the high-frequency generator P_g required for stable operation of the accelerator: $\eta = P_n/P_g \equiv (nN\Delta E)/[P_t + P_r + (n\Delta E/k) + n\Delta E(n-1)]$. Here n is the number of accelerated electrons per unit time, N is the number of orbits, ΔE is the increase in energy per orbit, P_t is the power loss in the waveguide tract, P_r is the ohmic loss in the walls of the resonator, and k is the capture coefficient defined as the number of electrons in the beam to the number of injected electrons. At present, the efficiency of the microtron is not over 7% for 6-Mev electrons (N = 12) due to the significant loss in power because of water cooling ($P_t \equiv 0.5$ to 0.6 P_g (the minimum power of the high-frequency generator)), and because of the low value of k (equal to ~3%). Addition of a ferrite valve as a decoupling element increased the efficiency approximately by a factor of two (here $P_t \equiv 0.25\ P_g$) and improved the operating stability of the high-frequency section. The whole system could be put in a vacuum on decreasing the flight path of the electron. The capture coefficient k was increased to ~10% by putting a positive bias of 2 to 3 kilovolts on the cathode. A pulse of ~110 ma of 6.5 Mev electrons can now be obtained from the electron cyclotrons as a result of these improvements. New cathodes will have to be developed in order to increase the current strength further because of cathode evaporation as a result of overheating. (TTT)

40149 ETL 25 Mev BETATRON. II. FIELD DISTRIBUTIONS AND FIELD CORRECTION. Takio Tomimasu. Denki Shikensho Iho, 29: 193-8(1963). (In Japanese)

Field distributions are investigated by the peaking strip and the search coil methods. The peaking strip used is a 0.05 mm × 20 mm Mo-Permalloy needle. An output pulse from pickup coils wound around the peaking strip has a 0.5 v pulse height and a 2 μs pulse width in case of 4000 gauss peak field. The 1st and 2nd harmonic components of field bumps are so large, $\Delta B/B = 1/3$ near the injection time, that any electron beam could not be observed. After the 1st and 2nd harmonic corrections and n-value correction with correction coils, the dose rate has increased to 5 r/m at 1 m in case of electron energy 20 Mev, injection voltage 35 kv, and emission current 300 μamp. (auth)

40150 A 300-Gev ACCELERATOR FOR EUROPE? C. C. Butler (Imperial Coll. of Science and Tech., London). New Scientist, 19: 377-9(Aug. 22, 1963).

A working party from the European Organization for Nuclear Research (CERN) reports on the need of construction of a 300-Bev accelerator. The machine would be a synchrontron of conventional type with a mean diameter of 2400 meters and magnets containing 27,000 tons of iron. The proton injector for the 300-Bev accelerator would be a 6-Bev synchrotron. The accelerator would generally be used as a rich source of secondary particles (mesons(π), mesons(K), etc.) at energies up to 30 Bev. The working party favors construction, provided government authorization is obtained by 1965 so that the machine may be completed by 1975. Some effects on European activities in high-energy physics are discussed as well as world repercussions. (R.E.U.)

40151 DEVICE FOR DEVELOPING MAXIMUM γ RADIATION IN EXTERNAL INJECTION SYNCHROTRONS. N. S. Solov'ev (Lebedev Inst. of Physics, Moscow). Zh. Tekhn. Fiz., 33: 945-8(Aug. 1963). (In Russian)

Descriptions are given of a device for obtaining maximum γ radiation in a synchrotron programmed by a computer. The device is capable of automatic detection and retention of synchrotron radiation at a maximum level during slowly changing operations (magnetic field compensation), temperature fluctuations, and residual magnetic fields. Gamma regulating parameters are selected for the inflection plate nearest the accelerating chamber, for compensating distortion of betatron orbits near the inflector, for switching in high-frequency acceleration at the assigned rate, and for currents for compensating azimuthal magnetic field distortions. The device operates at accelerator frequencies to 50 Hertz. (R.V.J.)

40152 MEASUREMENTS AND THEORETICAL INTERPRETATION OF HALL CURRENTS FOR STEADY AXIAL DISCHARGES IN RADIAL MAGNETIC FIELDS. Philip Brockman, Robert V. Hess, and Richard Weinstein (Langley Research Center, Hampton, Va.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-382, 15p, $1.00. (CONF-226-5)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

Experiments for Hall-ion accelerators are presented using axial electric fields and radial magnetic fields. Measurements of the variation of Hall currents with magnetic field for various constant axial currents are presented together with voltage variations. The pressures in the experiments vary from 6 to 40 μ Hg, the magnetic fields from 0 to 500 gauss, and the currents from 1 to 40 amperes. The Hall currents first increase with magnetic field and then decrease again as the magnetic field is increased. The variation can be interpreted in terms of Joule- and ion-slip losses for the partially ionized plasma used in the experiments. The effect of transition to turbulence is also evaluated and the present state of the theory for turbulent conduction is discussed. Preliminary experiments for preionization and for the heating of ring-shaped cathodes to thermionic emission are discussed. (auth)

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Refer also to abstracts 38624, 38625, and 38626.

40153 (AD-290727) INVESTIGATIONS ON THE DIRECT CONVERSION OF NUCLEAR FISSION ENERGY TO ELECTRICAL ENERGY IN A PLASMA DIODE. Period Covered: February 1, 1962 to October 31, 1962. Frank E. Jamerson, ed. (General Motors Corp. Research Labs., Warren, Mich.). Oct. 31, 1962. Contract NONR-3109(00). 137p.

Results of experimental and theoretical investigations are presented on the use of a nuclear generated plasma in a noble gas plasma diode thermionic converter. Related programs of emitter materials development and plasma measurements are described. These are presented in the following individual sections: inpile ion chamber experiment-theory and tube design, pulsed noble gas plasma diode experiments, electron mobility in gases, spectroscopic measurements in a cesium low voltage arc converter, and uranium carbide-rhenium cermet emitter. (auth)

40154 (AERE-M-1213(Pt.III)) THE ENGINEERING CONCEPTS OF EQUIVALENT NETWORKS, TRANSFER FUNCTIONS, AND FIELD IMPEDANCE IN MAGNETOHYDRODYNAMICS. PART III. STABILITY IN CYLINDRICAL GEOMETRY OF AN INFINITELY CONDUCTING FLUID. J. Contos (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Aug. 1963. 19p.

The engineering concepts of equivalent networks, transfer functions and field impedance previously developed are used to investigate the stability of a simple magnetohydrodynamic system. Both sausage instability and the stabilised pinch are discussed in terms of these concepts, and it is shown how a simple loop diagram picture can be built up which permits the stability problem to be readily analysed. (auth)

40155 (ARL-63-159) THEORETICAL AND EXPERIMENTAL INVESTIGATION OF MICROWAVE SCATTERING FROM A CYLINDRICAL PLASMA. S. W. Bowen, D. W. Cheatham, Jr., J. A. Nicholls, and B. P. Selberg (Michigan. Univ., Ann Arbor). July 19, 1963. Contract AF33(616)-8126. 20p.

A theoretical and experimental study was made of a modest temperature plasma obtained by seeding with low ionization potential elements. A detailed thermochemical analysis of nitrogen or air as the carrier gases and sodium, potassium, or cesium as the seeding elements was made. The results are presented for a range of seeding ratios and temperatures up to 4000°K. The experimental facility consisted of an rf plasma generator which produced a low velocity cylindrical plasma at 1 atm pressure and a temperature of 2750°K. Seeding was accomplished by using an atomizer and aqueous solutions of the nitrates of the seeding elements. The phase and amplitude of 3-cm microwaves scattered from the finite length, cylindrical, thermal plasma were measured by a microwave interferometer. These measurements were compared to the theoretical predicted values as obtained from an IBM 7090 computer program which considered the scattering of a plane incident electromagnetic wave from a homogeneous, cylindrical, infinite length plasma with properties based on the Saha equation ionization and available collision cross section data. Consistent, unexplained differences between experiment and theory are noted. 38 references. (auth)

40156 (ARL-63-182) DYNAMICS OF NON-LINEAR PLASMA OSCILLATIONS. Technical Note No. 3. G. Kalman (Paris. Universite) and G. Toulouse (Paris. Universite. Ecole Normale Superieure). June 15, 1963. Contract AF61(052)-613. 31p. (TN-313; LP-26)

A consistent perturbation method for the calculation of non-linear effects in plasma oscillations in a one component system without magnetic field, is studied. The unperturbed state is that of a cold plasma, without thermal particle motion; particle-plasmon interaction appears through non-linearity only. A diagram technique is worked out which facilitates the application of some field theoretic methods. The frequency-shift due to non-linearities (self-energy effect) is calculated in detail. (auth)

40157 (CLM-R30) THE TIME CONSTANTS OF THE SUSTAINED DIFFUSE PINCH. E. P. Butt and R. S. Pease (United Kingdom Atomic Energy Authority. Research Group. Culham Lab., Culham, Abingdon, Berks, England). June 1963. 19p.

Diffuse pinch configurations were found theoretically by Whiteman which are stable on the energy principle at low values of β. Because the plasma is both ohmically heated and drifts in the electric field sustaining the currents, the configuration changes with time and will remain stable only for a limited period. The time constant for both phenomena scale as σR^2; σ is the conductivity, R is the plasma radius. Over-heating can be avoided by radiation cooling; the drift of the plasma in low-β pinch configurations is relatively slow, but the time taken to drift into an unstable configuration is sensitive to the details of the assumed initial density distribution and to processes in the boundary regions. (auth)

40158 (CNAEM-10) CORRELATIONS IN PLASMAS. PART I. TERNARY CORRELATIONS. Kaya Imre and Ercuement Ozizmir (Turkey. Atomic Energy Commission. Cekmece Nuclear Research Center, Istanbul). Aug. 1963. 36p.

The kinetic stage of an interacting, multi-component system is studied using Bogoliubov's formalism including terms up to the second order in interaction strength λ, but to all orders in $n\lambda$, n being the density. It is shown that the second order s-particle distribution function can be expressed in terms of zero and first order binary and zero order ternary correlation functionals. This functional form is also shown to be deducible in a prescribed manner from the so-called cluster expansion series of the equilibrium theory. The latter observation provides a means for guessing the structures of the higher order distribution functionals. The equations satisfied by the first order binary and zero order ternary correlation functionals are derived. They constitute a coupled set of equations determining the second order contribution to the kinetic equation. Explicit expressions are found for the correlation functions when the one-particle distribution function is Maxwellian. The results in this case, are in agreement with those obtained from the equilibrium theory. (auth)

40159 (LA-2940) TWO-METER MACH-ZEHNDER INTERFEROMETER FOR PLASMA DENSITY MEASUREMENTS. W. H. Borkenhagen, F. L. Ribe, and G. A. Sawyer (Los Alamos Scientific Lab., N. Mex.). July 1, 1963. Contract W-7405-eng-36. 22p.

The design, adjustment, and performance of a Mach-

Zehnder interferometer are described. The instrument was designed for measuring plasma densities in a θ-pinch discharge. The interferometer has a 2-meter clearance in its upper, test, optical path and uses 6-in. mirrors. (auth)

40160 (NP-13136) INTERACTION OF A STREAMING PLASMA WITH THE MAGNETIC FIELD OF A TWO-DIMENSIONAL DIPOLE. Research Report 159. R. H. Levy (Avco Corp. Avco-Corp. Avco-Everett Research Lab., Everett, Mass.). Aug. 1963. Contract NAS-w-748. 13p.

The flow of an infinitely conducting plasma past a two-dimensional magnetic dipole pointed into the flow was considered. The solution has features of Hurley's and of Cole and Huth's problems for parallel orientation of the dipole and for no flow, respectively. Apparently flows having trapped regions in this type of magnetohydrodynamics can be constructed from simpler situations with little error. (auth)

40161 (NP-13153) PLASMA PHYSICS. A Course of Lectures Delivered at the Saha Institute of Nuclear Physics, March–April 1963. S. K. Trehan (Delhi. Univ.). 82p.

The equations for the particle and macroscopic motions in a plasma in electromagnetic fields are derived. The Boltzmann equation is generalized to obtain the equations. Consequences and applications (thermonuclear research, etc.) of equations are examined. Landau damping, stability, and oscillations are some of the particular aspects covered. (D.C.W.)

40162 (SCR-692) PLASMA DIAGNOSTICS WITH SHORT ELECTROMAGNETIC PULSES. Hans J. Schmitt (Harvard Univ., Cambridge, Mass.). July 1963. Contract [AT(29-1)-789]. 22p.

Sandia Corp. Monograph.

The propagation of short electromagnetic pulses in an ionized medium and the reflection of transient pulses from bounded ionized regions is discussed. Analytical expressions for transient oscillations in reflected and propagated electromagnetic fields excited by a unidirectional pulse are derived for certain simple cases. The transient oscillations show a periodicity that is directly related to the plasma frequency and are useful for nearly instantaneous plasma diagnostics. An experiment is described in which the reflection and transmission of unidirectional pulses of approximately 1-nanosecond duration is observed in the afterflow of a coaxial discharge tube. In addition to the dispersion of the quasi TEM mode in the coaxial test tube, a transient oscillation with much lower periodicity is also observed and is interpreted as arising from a surface-wave propagating near the interface between glass walls and the annular ionized region. This surface-wave propagates only at frequencies below the plasma frequency of the ionized region, and its application for diagnostics of dense plasmas is indicated. (auth)

40163 (TID-19431) THERMONUCLEAR PLASMA STUDIES. Quarterly Status Report No. 2. (Wisconsin. Univ., Madison). July 15, 1963. Contract AT(11-1)-1233. 13p.

The design dimensions for the toroidal octupole apparatus were determined by digital computer tests of trial geometries. An analysis showing zones for absolute containment of particle orbits in toroidal multipoles was also carried out. (auth)

40164 (UCRL-6811) DEVELOPMENT OF A 50-MEGAWATT MAGNETIC MODULATOR TO SIMULTANEOUSLY TRIGGER 500 THYRATRONS. Bernard M. Loth (California. Univ., Livermore. Lawrence Radiation Lab.). May 15, 1962. Contract W-7405-eng-48. 32p. (CONF-237-1)

From 7th Symposium on Hydrogen Thyratrons and Modulators, Fort Monmouth, N. J., May 1962.

The Astron device requires for its operation a pulsed electron beam with an energy of 5 Mev ±0.5%. The required beam current is 200 amp with a pulse duration of 0.25 μsec. The beam will be pulsed at 60 pps. A linear induction accelerator is being constructed using a large number of magnetic cores excited by 400 line-type thyratron modulators triggered simultaneously. The trigger for these modulators will be provided by a magnetic modulator supplying 50 Mw of peak power. A technique was developed for producing multiple synchronized pulse outputs from a magnetic modulator and at the same time maintaining electrical isolation between output pulses. Several prototype magnetic modulators utilizing this construction are described. A single-stage magnetic modulator capable of producing a 0.4-μsec pulse with a peak power of 70 Mw into a 1.4-ohm resistive load was built. The core losses of this modulator and their relation to output pulse stability is discussed. The temperature profile of the modulator core under 60 pps operation is discussed in detail. A three-stage magnetic modulator capable of generating a 2250-volt, 0.4-μsec pulse into a 0.1-ohm resistive load with a rise time of 100 nsec is described. This pulser will be powered from a single silicon-controlled rectifier. The electrical isolation of the multiple outputs and the simultaneity of outputs is described for a prototype two-stage modulator developing 1800 across a 0.1-ohm load. (auth)

40165 (USCEC-82-205) EXCITATION OF WAVES IN A WARM PLASMA BY AN ELECTRIC DIPOLE. Hans H. Kuehl (University of Southern California, Los Angeles). Sept. 1962. Contract AF19(604)-6195. 28p. (AFCRL-62-737; EE-15; AD-291821)

The general expression for the monochromatic electromagnetic field due to an electric dipole immersed in an unbounded, homogeneous, warm, collisionless plasma in the absence of a magnetostatic field is derived. A hydrodynamic description is used and the limitations of this approach as applied to the problem are considered. It is found that the field is generally composed of three parts which, in the radiation region, correspond to the well-known transverse, longitudinal electron, and longitudinal ion waves. The power flow in the radiation region is shown to be largest along the axis of the dipole for low frequencies, whereas the maximum occurs perpendicular to the dipole at high frequencies. (auth)

40166 OPTIMUM ISOTHERMAL ACCELERATION OF A PLASMA WITH CONSTANT MAGNETIC FIELD. J. H. Drake (Lockheed Missile and Space Co., Palo Alto, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 2053-7(Sept. 1963).

On the basis of one-dimensional gasdynamics and the methods of the calculus of variations, a numerical solution was obtained that for given inlet and outlet conditions and constant magnetic field determines the minimum length isothermal crossed-field accelerator. Since the results are presented in a nondimensional form, it is possible to design many MHD accelerators with a variety of operating conditions. By comparing the optimum solution with various other isothermal solutions, it can be shown that considerable reductions in length are possible. The analysis thus indicates that there is much to be gained from improved accelerator design. (auth)

40167 CONTINUUM ASPECTS OF rf GRADIENT ACCELERATION OF PLASMA. J. A. Cooney (Radio Corp. of America, Princeton, N. J.). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 2190-2(Sept. 1963).

A quasi-one-dimensional model of acceleration of a continuum plasma by r-f electric field gradient forces is examined. The conditions imposed on the electric field in order to effect sonic transitions are given. The case of isentropic flow is treated, and departure from the particle model is indicated for pressure >100 μ and temperatures $\simeq$0.1 ev. (auth)

40168 QUANTUM MECHANICAL KINETIC EQUATIONS. H. W. Wyld, Jr. (Univ. of Illinois, Urbana) and Burton D. Fried. Ann. Phys. (N. Y.), 23: 374-89(Sept. 1963).

A new derivation of a Boltzmann collision integral with a dynamically screened Coulomb interaction is presented. Correlation functions referring to equal and different times and formulas for the density-density autocorrelation function in a quantum-mechanical plasma are given. The collision integral is obtained for a dilute gas of particles interacting via strong short-range forces. (R.E.U.)

40169 ION CYCLOTRON RESONANCE IN A MOVING PLASMA. I. I. Baknev, Yu. G. Zalesskii, I. I. Nazhrov, A. M. Ukrainskii, and V. T. Tolok. At. Energ. (USSR), 15: 3-6(July 1963). (In Russian)

Ion cyclotron resonance is a rapid method of heating a plasma bundle for injection into a magnetic trap. In order to investigate this method of heating a moving plasma, a plasma waveguide was made up in the form of a tube of molybdenum glass 75 mm in diameter and 2 m long. A vacuum of about 10^{-6} mm Hg std was created in the tube, and hydrogen gas was injected in bursts into one end of the tube about 45 cm from the edge of the homogeneous longitudinal magnetic field created by discharging an electrical current through a solenoid surrounding the tube. The velocity of the plasma bundle was found to be $V_p = 6.7 \times 10^6$ cm/sec, as measured by an electric probe in the plasma, and by the rate of rise of the loading on the circuit created by the plasma bundle (the rise time of the plasma bundle is about 6 μsec). Absorption of high-frequency energy by the plasma bundle is observed at two frequencies that are displaced on both sides of a certain average frequency as a result of the Doppler effect. With two magnetic barriers (on each side of the solenoid), two high-energy absorption peaks are observed because of the damping of two ion cyclotron waves having frequencies of ω_1 and ω_2. With the removal of one of the magnetic barriers, one of the ion cyclotron waves is reflected into the solenoid coil, and only a single absorption peak is observed. The density of the plasma bundle was found to be 7×10^{12} cm^{-3}, as calculated from the dispersion relationship for a stationary plasma. (TTT)

40170 OSCILLATIONS OF A SPATIALLY INHOMOGENEOUS PLASMA IN A MAGNETIC FIELD. V. G. Davidovskii. At. Energ. (USSR), 15: 60-1(July 1963). (In Russian)

A magnetohydrodynamically stable plasma can be unstable with respect to short-wavelength oscillations which create a local field inhomogeneity and lead to anomalous diffusion effects with a slow drift of the plasma from the system. The rate of anomalous diffusion is determined by the wave amplitude and the number of particles in resonance with the wave. The wave increment must be known as a function of the projection of phase velocity in the direction of the magnetic field. A dispersion equation is presented for the oscillations of a dilute, collision-free plasma having density and temperature gradients along one axis. It is assumed that $p^2/(H^2/8\pi) \ll 1$, and $(\omega/\omega_{Bi}) \ll 1$. Here ω is the frequency of the oscillations, and ω_{Bi} is the Larmer ion frequency. A function for the distribution of particles in the plasma is assumed. Solution of the dispersion equation indicates the existence of the following oscillations: $\omega = Q_\theta - [\phi'(\theta/2)R_\theta/(1-\phi)]$. Here Q_θ and R_θ are functions involving the number of particles and the temperature of the plasma. Only a very small part of the ions but a significant fraction of the electrons can be trapped by the resonant oscillation. (TTT)

40171 ON THE BOUNDARIES OF MOTION IN MAGNETIC TRAPS. R. Klima (Inst. of Vacuum Electronics, Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 13: 611-12(1963). (In English)

The possibility of the closure of boundaries of the motion of particles in magnetic traps is investigated by means of the evident integrals of motion. (R.E.U.)

40172 ELLIPTICAL-HYPERBOLIC TRANSITION REGIMES IN CERTAIN MAGNETODYNAMIC FLUID FLOWS. Roger Peyret (Université, Paris). J. Mecan., 1: 167-78(June 1962). (In French)

In a preceding article (J. Mecan., 1: 31(1962)) regimes of stationary flow of a perfect, compressible, completely conducting fluid exposed to a magnetic field parallel to the flow were studied using an analogy with gas dynamics that is valid when the Alfvén number is higher than 1. These results are extended to the four transition regimes for which $A = 1$, $M = 1$, $A^2 + M^2 = 1$, and both A and M approach 1, where A is the Alfvén number and M is the Mach number. The theory of small perturbations is used and is described together with the flow equations. Two of these regimes ($A_\infty^2 + M_\infty^2 \neq 1$ and $M_\infty \neq 1$, $A_\infty \neq 1$) show some analogies with the transsonic regime of gas dynamics. The two other regimes are strongly different: for each of these regimes there are two parameters of similitude of which one is the Mach number M_∞ itself. There is no perturbation current function or perturbation flow potential. (J.S.R.)

40173 ROLE OF THE VELOCITY OF IONS DURING EXCITATION OF PLASMA OSCILLATIONS BY AN ION BEAM. M. D. Gabovich and G. S. Kirichenko (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 8: 624-7(June 1963). (In Ukrainian)

The dependence of the frequency and amplitude of plasma oscillations excited by a beam of slow ions was investigated. In qualitative agreement with the theory, stability of the ion beam was observed at ion energies of several kT_e. (auth)

40174 INTERACTIONS OF RELATIVISTIC NEUTRAL CHARGED PARTICLE BEAM WITH MAGNETOACTIVE PLASMA. V. G. Makhan'kov. Zh. Tekhn. Fiz., 33: 897-900(Aug. 1963). (In Russian)

Studies were made of electromagnetic waves in a system of magnetoactive plasma and neutral charged particles moving at a relativistic rate parallel direction to an external magnetic field. An increment of excitation was developed for longitudinal waves and magnetic field waves propagating along the external field when the thermal motion of particles is neglected. (R.V.J.)

40175 ACCELERATION OF PLASMA CLUSTERS BY A PLASMA FLUX IN MAGNETIC FIELD. M. L. Iovnovich. Zh. Tekhn. Fiz., 33: 901-4(Aug. 1963). (In Russian)

Investigations of small plasma cluster interactions with a plasma flux in a homogeneous magnetic field showed an effective cluster acceleration by a dense magnetic flux.

Linearized systems of equations indicate a rising coherent force pressing on the clusters. (R.V.J.)

40176 ELECTROMAGNETIC WAVES IN NON-LINEAR DISPERSION MEDIA. L. A. Ostrovskii. Zh. Tekhn. Fiz., 33: 905-8(Aug. 1963). (In Russian)

Studies of quasi-chromatic wave propagation in a nonlinear dispersing media showed that under certain conditions the wave amplitude changes according to a simple (Riemann) wave, followed by a change in frequency. (tr-auth)

40177 DISSIPATIVE INSTABILITY OF WEAKLY IONIZED HETEROGENEOUS PLASMA IN HOMOGENEOUS EXTERNAL FIELD. A. V. Timofeev. Zh. Tekhn. Fiz., 33: 909-14(Aug. 1963). (In Russian)

Stability of a weakly ionized heterogeneous plasma in a homogeneous magnetic field was analyzed, considering dissipation produced by charged particle collisions with neutral atoms. It was found that with sufficiently large magnetic fields and density gradients the plasma becomes unstable. (tr-auth)

40178 RELATIVISTIC DISSIPATION OF CYCLOTRON OVERTONES IN PLASMA. V. P. Demidov and D. A. Frank-Kamenetskii. Zh. Tekhn. Fiz., 33: 915-21(Aug. 1963). (In Russian)

The influence of relativistic effects on ordinary wave absorption near electron cyclotron frequency harmonics was estimated. Solutions were found for dispersion equations and for supplementary damping that takes place in sufficiently hot, dense plasma. (R.V.J.)

40179 WAVE PROPAGATION IN PLASMA NEAR CYCLOTRON RESONANCES. Yu. N. Dnestrovskii, D. P. Kostomarov, and N. V. Skrydlov. Zh. Tekhn. Fiz., 33: 922-8(Aug. 1963). (In Russian)

Wave propagation in plasma, across a magnetic field, close to the region of electron cyclotron resonance was investigated using relativistic dispersion equations. Asymptotic formulas developed for absorption and diffraction coefficients for waves of various types hold good for all resonance points. Graphs are given for actual and assumed components of dielectric penetrability tensors. (R.V.J.)

40180 REFLECTION AND REFRACTION OF MAGNETOHYDRODYNAMIC WAVES AT THE BOUNDARY OF TWO ANISOTROPIC PLASMA MEDIA. Ts. D. Loladze and M. L. Tsintsadze (Inst. of Physics, Academy of Sciences, Georgian SSR). Zh. Tekhn. Fiz., 33: 929-34(Aug. 1963). (In Russian)

Equations were derived for reflection and refraction of magnetohydrodynamic waves at the boundary between two anisotropic plasma media. Derived amplitude ratios indicate only alpha reflection and refraction waves for alpha wave incidence and, respectively, only fast and slow magnetoacoustic wave reflection and refraction in fast and slow magnetoacoustic waves. Moreover, short reflection and refraction waves appear at an anisotropic alpha rate close to zero. Studies indicated that the wave reflection and refraction at the boundary are similar to reflection and refraction at a rigid wall. (R.V.J.)

40181 THE THEORY OF ELECTROMAGNETIC WAVE REFLECTION FROM PLASMA. I. A. Akhiezer (Inst. of Physics and Tech., Khar'kov). Zh. Tekhn. Fiz., 33: 935-42(Aug. 1963). (In Russian)

Equations were derived for electromagnetic wave reflection from a semi-infinite plasma, considering plasma fluctuations and the difference between reflection angles and frequency and incidence angles and frequency. Theoretical studies of incoherent electromagnetic wave reflection from plasma, ordinarily, are limited to the solution of scattering at angles $< \pi/2$. However, in this work the coefficient of incoherent electromagnetic wave reflection was determined considering the boundary. The boundary played an important part in cases in which the incident or reflected wave frequency was comparable to the plasma frequency and in cases of sliding incidence or reflection. (R.V.J.)

40182 STRUCTURE OF A SHOCK WAVE PROPAGATING IN RAREFIED PLASMA AT AN ARBITRARY ANGLE TO THE MAGNETIC FIELD. V. I. Karpman (Norosibersk State Univ., USSR). Zh. Tekhn. Fiz., 33: 959-66(Aug. 1963). (In Russian)

The structure of a shock wave propagating in rarefied plasma in a strong magnetic field ($H_2/8\pi \gg p$) at any arbitrary angle except $\theta \lesssim \sqrt{m_e/m_i}$, $(\pi/2) - \theta \ll 1$, was studied. (R.V.J.)

40183 CORRELATION OF SUPERHIGH FREQUENCY AND PROBE METHODS FOR MEASURING PLASMA DENSITY. V. V. Zubov and P. N. Chistyakov. Zh. Tekhn. Fiz., 33: 967-72(Aug. 1963). (In Russian)

Data on plasma density in a positive stationary mercury discharge column collected by probe and by super-high frequency methods were correlated. At pressures below 2×10^{-2} mm Hg the difference did not exceed 25%. At higher pressures the difference reached 75%. In all cases the probe measurements were lower than those obtained by the super-high frequency method. (R.V.J.)

40184 LOCALIZATION OF HIGH-FREQUENCY INDUCTION DISCHARGE. M. D. Raizer, A. G. Frank, and V. F. Kitaeva (Lebedev Inst. of Physics, Moscow). Zh. Tekhn. Fiz., 33: 1011-20(Aug. 1963). (In Russian)

It was found that a plasma loop stripped from the vacuum chamber wall and retained during the span of a high frequency pulse was formed in a high frequency induction discharge in a bell-shaped magnetic field at gas pressures over 1.0 mm Hg. Ionization, gas temperature, and plasma conductivity were determined, and a qualitative explanation for charge localization was given on the basis of a hydrodynamic model for weakly ionized plasma. (tr-auth)

40185 EMISSION OF RECOMBINATION RADIATION AND BREMSSTRAHLUNG FROM A PLASMA. L. M. Biberman and G. E. Norman. J. Quant. Spectry. Radiative Transfer, 3: 221-45(July-Sept. 1963). (In Russian)

The method is developed for the computation of equilibrium plasma absorption coefficients due to the photoionization of excited complex atoms. In addition to bound–free transitions, free–free transitions of electron in the fields of positive ions are treated. Expressions are derived which take into account both types of processes. The formulas obtained may be applied to a plasma consisting of atoms and ions of any degree of ionization. The peculiarities are discussed which arise from the multiplicity of complex atom energy-level spectra and from the excited states of parent ions. Expressions for absorption coefficient and radiation intensity are presented in a form which is similar to that used in Unsöld's formulas. It is shown that Unsöld's formulas yield results which are incorrect in order of magnitude in some cases. The numerical results are presented for a number of atoms and ions. Agreement is good with available experimental data. The scopes and limits of validity of the expressions, which were derived, are discussed. (auth)

40186 ON THE ACCURACY OF SPECTROMETRIC MEASUREMENT OF PLASMA TEMPERATURE. R. W.

Porter and T. P. Anderson (Northwestern Univ., Evanston, Ill.). J. Quant. Spectry. Radiative Transfer, 3: 279-83 (July-Sept. 1963). (In English)

Two emission spectroscopic methods for measuring plasma temperatures are described: the two-line and normalized intensity methods. The theory of the methods is outlined, and expressions are derived for the error in temperature determinations. Modifications of the two-line method are considered. It is concluded that the normalized intensity method is more accurate and is preferred. (D.L.C.)

40187 MICROWAVE PROPAGATION THROUGH A MAGNETOPLASMA PRODUCED BY RADIO FREQUENCY DISCHARGE. Yuichi Sakamoto (Inst. of Physical and Chemical Research, Tokyo). Japan. J. Appl. Phys., 2: 587-8(Sept. 1963). (In English)

The properties of the transmission of electromagnetic waves in magnetoplasmas along the external magnetic field were studied by employing a radiofrequency tube to form a part of a circular waveguide system. (auth)

40188 SLOW EXPANSION OF A PLASMA COLUMN WITHOUT THE APPLICATION OF A MAGNETIC FIELD. P. Avivi, N. Ben-Yosef, F. Deutsch, and A. S. Kaufman (Hebrew Univ., Jerusalem). Nature, 199: 1244-6(Sept. 28, 1963).

The device, Maya, was built with the view of creating and investigating a plasma originating in the positive column of an arc discharge, during and subsequent to the rapid ejection of the discharge-tube walls. During the testing of Maya without an applied magnetic field, it was observed that electrostatic probes, situated outside the initial boundary of the positive column in hydrogen, responded to the arrival of electrons only after a delay of abour one to two milliseconds from the commencement of ejection. In addition, if two probes were set at the same radial distance from the discharge tube, then the one farther from the exposed column responded to the arrival of electrons a perceptible fraction of a millisecond later than the probe situated more closely. Similar effects were observed for positive-ion collection. It was thus evident that during ejection the plasma column expanded from the boundary of the discharge tube into the space between the two vessels. The speed of the plasma expansion was computed by two different methods. From an examination of some 20 runs, the initial delay in electron collection and the delay between probes both indicated the same result, namely, a speed of plasma expansion of about 10^4 cm sec^{-1}. (M.C.G.)

40189 A PLASMA FLOWMETER: THE "PLASMA EATER." I. Alexeff and R. V. Neidigh (Oak Ridge National Lab., Tenn.). Nucl. Fusion, 3: 23-7(Mar. 1963). (In English)

The "plasma eater" is a device that measures the rate of flow of a neutral plasma. The device absorbs or "eats" the plasma entering it and yields a current equal to the number of electrons entering the device per second. An experimental model of the device was successfully used with the plasma column of a reflex discharge to measure steady state plasma flow rate, ion density, and plasma decay time. (auth)

40190 DRIFT INSTABILITY OF A PLASMA IN A HELICAL MAGNETIC FIELD. L. V. Mikhailovskaya and A. B. Mikhailovskii (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 3: 28-9(Mar. 1963). (In Russian)

The effect of the shear of the lines of force of a helical magnetic field on the drift instability of a plasma is considered. The conditions are found in which such instability is possible. (auth)

40191 CYCLOTRON INSTABILITY OF A PLASMA. Yu. N. Dnestrovskii (Moscow State Univ.), D. P. Kostomarov, and V. I. Pistunovich. Nucl. Fusion, 3: 30-7(Mar. 1963). (In Russian)

The cyclotron instability of a plasma in a magnetic field when the ion distribution function is anisotropic in velocity space is studied. For perturbations in the form of plane waves with various wave vectors k, the values of plasma parameters are determined at which instability appears (that is, the region of instability). Minimum values are found for the parameter $\tau = T_{i\perp}/T_{i\parallel}$ characterizing the anisotropy of ion temperatures—that is, the values at which the plasma begins to be unstable. It is shown that the largest region of instability corresponds to the long waves propagated almost perpendicularly to the external magnetic field. It is established that two conditions must be fulfilled for cyclotron instability to develop in a plasma with cold electrons: $T_{i\perp}/T_{i\parallel} > 2$, $\omega_{0c} > \omega_i/2$ (where ω_{0c} is the plasma frequency of the electrons and ω_i the cyclotron frequency of the ions). Heating the electrons improves the stability of the plasma—specifically, by raising the critical value of the parameter $T_{i\perp}/T_{i\parallel}$ from which instability appears. The growth rates of unstable solutions are calculated, and from the formulas for these it is evident that cyclotron instability has a resonance character. The waves that oscillate most strongly are those for which $\omega_{0c}k_z/\omega_i(k_z^2 + k_y^2)^{\frac{1}{2}} \approx n$ (n being a whole number). (auth)

40192 MAGNETO-SONIC RESONANCE AT HIGH FIELD AMPLITUDES. A. V. Borodin, I. A. Kovan, Ya. R. Rakhimbabayev, V. D. Russanov, V. P. Smirnov, and D. A. Frank-Kamenetzkii (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 3: 38-42(Mar. 1963). (In Russian)

Magneto-sonic oscillations were induced by a high power r-f generator serving simultaneously for ionization and heating of a plasma. With quasi-static magnetic field up to 15 kOe magneto-sonic resonance was observed. The amplitude of the high-frequency magnetic field in the plasma attained a value of 150 Oe compared with an initial amplitude of 10 to 12 Oe in the absence of the plasma. The Q of the circuit dropped by more than an order of magnitude because of the presence of the plasma, but this gives no direct indication of true energy dissipation inside the plasma since experimental conditions did not exclude energy loss through open ends of the cylinder. (auth)

40193 INFLUENCE OF COLLISIONS ON SCATTERING OF ELECTROMAGNETIC WAVES BY PLASMA FLUCTUATIONS. A. Ron, J. Dawson, and C. Oberman (Princeton Univ., N. J.). Phys. Rev., 132: 497-8(Oct. 15, 1963).

The incoherent scattering of electromagnetic waves from electron-plasma oscillations in a thermal plasma is investigated. In particular, the effect of collisions on the shape of the isolated peak in the scattered intensity at a frequency displaced from the incident frequency by the plasma frequency is discussed making use of Nyquist's theorem and recent conductivity calculations. (auth)

40194 MOMENTUM TRANSFER BETWEEN CHARGED AND NEUTRAL PARTICLES IN A WEAKLY IONIZED GAS. B. Durney (Compagnie Générale de Télégraphie Sans Fil, Orsay, France). Proc. Phys. Soc. (London), 82: 353-6 (Sept. 1, 1963).

The momentum transfer between charged and neutral particles of a slightly ionized gas in crossed electric and magnetic fields is evaluated with the help of the expressions for the drift velocity of ions and electrons. When the

longitudinal electric field vanishes the axial Lorentz force arises from collisions of either ions or electrons with the main gas depending on the values of the pressure and magnetic field. Both ionic and electronic transverse currents are possible. When the longitudinal current vanishes the transverse current is electronic and the axial Lorentz force is due essentially to collisions of the ions with the main gas. (auth)

40195 A THEORY OF THE TURBULENT ELECTRIC FIELD FLUCTUATIONS IN ELECTRON PLASMAS. [PART] II. Takao Tsuda (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 30: 17-33(July 1963). (In English)

An investigation is made on the energy distribution, in a wave number space, of the macroscopic turbulent electric field fluctuations in electron plasmas. Oscillatory longitudinal electric fields are expressed by means of collective coordinates as a system of coupled oscillators with nonlinear mode couplings. The model under consideration is such an electron plasma in which finite amplitude plasma oscillations are strongly excited through a long wavelength region and are thus sustaining a quasi-stationary state. An attempt is made to determine the energy spectral distribution in the wave number space approximately, by checking on frequency-shift relations, but without looking into the mechanism of thermalization processes. It is found that the curve of the energy spectral distribution rises linearly with k up to a critical wave number. Beyond the critical wave number that depends on the intensity of the turbulent fluctuations, the curve rapidly falls off to zero as an inverse square of k. (auth)

40196 TEN-KILOGAUSS, AIR-COOLED MAGNET FOR PLASMA RESEARCH. J. E. Rudzki and E. H. Holt (Rensselaer Polytechnic Inst., Troy, N. Y.). Rev. Sci. Instr., 34: 1155-6(Oct. 1963).

A 10-kOe, air-cooled, wet-cell battery-powered, helical-coil electromagnet is described. The magnet requires 1.5 v/kOe, and its calculated temperature rise for one minute of operation is 15°C. (T.F.H.)

40197 TWO-BEAM INSTABILITY. R. V. Polovin (Khar'kov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 8: 709-16(July 1963). (In Ukrainian)

A review is given of theoretical equations for two-beam plasma instability in the presence of external fields. (R.V.J.)

40198 INVESTIGATION OF PLASMA BY MEANS OF A MICROWAVE INTERFEROMETER. L. A. Dushin, V. I. Kononenko, R. I. Kovtun, A. I. Skibenko, K. D. Sinelnikov, and V. T. Tolok (Khar'kov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 8: 740-6(July 1963). (In Ukrainian)

Measurements of plasma parameters by its interaction with microwave pulses are described. A microwave interferometer for a 2 mm wavelength was employed for measurements of phase shift and signal decay, that permitted following up an electron density from 10^{12} to 10^{14} per cm^3. A decaying plasma in a Phillips pulsed source was investigated. The experimental curves of the time dependence of phase shift and signal decay were used to calculate the electron density and its spatial distribution, the collision frequency, and the diffusion and recombination coefficients. (auth)

40199 ON THE STABILITY OF CYLINDRICAL PLASMA SHEATH. V. V. Vladimirov (Kiev Inst. of Physics). Ukr. Fiz. Zh., 8: 803-5(July 1963). (In Ukrainian)

Dispersion equations for incompressible flow were previously derived on the basis of ideal magnetohydrodynamics. Stability criteria were found for each case of uniform surface flow in tubes. A quantitative analysis was made of the dispersion equations for describing the stability criteria. (R.V.J.)

40200 NON-STATIONARY OSCILLATIONS IN A COLD PLASMA. V. A. Levin. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 4, 114-15(July-Aug. 1963). (In Russian)

An investigation was made of nonstationary cold electron plasma oscillations. The obtained results were used in an analysis of plasma cluster splitting. (R.V.J.)

40201 ELEMENTARY PLASMA PHYSICS. Conrad L. Longmire, ed. Interscience Monographs and Texts in Physics and Astronomy, Volume IX. New York, Interscience Publishers, 1963. 306p. $9.75.

The problem of thermonuclear applications to plasmas is predominantly treated. Included are: basic equations and conservation laws; first-orbit theory and its application to static and dynamic problems; exact static solutions; small-amplitude plasma waves and hydromagnetic shocks; collision effects; diffusion in velocity space and in coordinate space across a magnetic field; stability; and coupling of plasmas and radiation. Gaussian units are used throughout. (R.E.U.)

40202 EXPERIMENTAL INVESTIGATION OF THE CHARACTERISTICS OF A LANGMUIR PROBE IN IONIZED LOW DENSITY FLOWS. Paul C. Wilber (Univ. of Southern California, Los Angeles). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-371, 10p, $1.00. (CONF-226-12)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

An experimental study of the performance of a charged circular cylinder immersed in an essentially uniform rarefied plasma stream is described. Data are presented for wide ranges of speed ratio, electron and neutral particle number densities, and electron temperature with the collector axis oriented both parallel and transverse to the flow. Results are discussed with respect to recently developed theory, which relates the probe measurements to local charged-particle density and temperature in the flowing plasma. (auth)

40203 PERFORMANCE OF A CONSTRICTED-ARC DISCHARGE IN A SUPERSONIC NOZZLE. Charles E. Shepard and Velvin R. Watson (Ames Research Center, Moffett Field, Calif.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-380, 8p, $1.00. (CONF-226-16)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

A new plasma generator was developed, which produces a supersonic gas flow at very high enthalpies. The design, based on the analysis of the constricted arc, was successfully tested with mixtures of nitrogen and air and nitrogen and carbon dioxide. The generator produces a steady supersonic gas stream, but the total enthalpy has a large gradient in the radial direction. With nitrogen, the average enthalpy of the stream is ~30,000 Btu/lb whereas the center-line enthalpy was estimated to be 80,000 Btu/lb. The new plasma generator is described and the results of some experiments are compared with theory. The pertinent arc-scaling laws are discussed. (auth)

40204 COMPARATIVE SPECTROSCOPIC STUDIES OF ELECTROMAGNETICALLY DRIVEN HYPERSONIC WAVES IN ELEMENTAL GASES AND DETONABLE MIXTURES. Kenneth M. Foreman and Maurice E. Levy (Republic Avia-

tion Corp., Farmingdale, N. Y.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-375, 10p, $1.00. (CONF-226-8)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

Time-resolved emission spectroscopy has been used to analyze electromagnetically driven plasmas created by arc discharges in quiescent, low-pressure elemental gases and detonable mixtures. The electrical energy was supplied by an R-L-C circuit in the form of an 8 μsec pulse. Hyperboloid contoured stainless steel electrodes mounted in parallel within a cylindrical discharge chamber created a constant-area flow channel in which wave speeds between 8,000 and 25,000 ft/sec were recorded. The relative excitation of hydrogen Balmer lines, the long decay time of the 5876 Å helium emission line, and the time variation of molecular oxygen-ion emission are typical data presented (and related to the arc-discharge-current waveform). Also presented is the emission spectrum from a stoichiometric hydrogen–oxygen mixture. Radiation from the $H_2 - \frac{1}{2} O_2$ mixture with an initial pressure between 1 and 11 mm Hg (absolute) includes the 5126 Å band attributed to OH. These data indicate that it is likely that an exothermic chemical reaction proceeds within the order of 1 μsec downstream of the driven hypersonic-wave field. It is believed that the reaction mechanism can be partially attributed to photochemical processes caused by ultraviolet radiative transfer from the intensely luminous plasma in the arc region. (auth)

40205 IONIZATION PROFILES IN LOW PRESSURE EXHAUSTS. T. Herbert Dimmock and William R. Kineyko (Thiokol Chemical Corp., Denville, N. J.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-388, 16p, $1.00. (CONF-226-1)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

The ionization profile along the axis of a seeded, Mach 3, high-altitude rocket exhaust was mapped by microwave and probe techniques. The ionization density in the jet was as high as 10^{13} electrons/cm^3 and was found to vary half an order of magnitude between expansion and shock regions. The relaxation in the jet was evaluated from the measured data. Since the ionization was found to follow the gas density profile, it was concluded that the relaxation time was at least as long as the transit time between the shock waves, and that the residence time in the shock zone was sufficient to sustain this ionization. Cases in which the residence time is less than the thermalizing time are illustrated. The thermodynamic properties in the jet were measured by pressure and temperature probes and by line reversal spectroscopy. Unfortunately it was necessary for the probe dimensions to be comparable to the jet dimensions, thus the excursions in pressure and temperature along the profile were reduced and results are average values only. The microwave method was found to be suitable for analysis of low-pressure seeded jets as long as the collision frequency is of the order of 10^9 sec^{-1} and the electron density lies between 5×10^{11} and 2×10^{12} electrons/cm^3. Such a plasma would then have a d-c conductivity of the order of 100 mhos/m. (auth)

40206 A SURVEY OF OPTICAL INTERFEROMETRY AS APPLIED TO PLASMA DIAGNOSTICS. Alan F. Klein (Aerospace Corp., El Segundo, Calif.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-377, 11p, $1.00. (CONF-226-7)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

The principles and techniques involved in the application of optical interferometry to plasma studies are reviewed. The assumptions and accuracy of the theoretical calculations are summarized. Experiments to date in the field are reviewed, and recent experiments are described in which monochromatic interferograms about two-dimensional, sharp and blunted bodies were obtained using an image converter camera and an exploding wire light source. Resolution times down to 20 nanoseconds were obtained while maintaining a conventional field of view. Using the multiple frames provided by the image converter camera, the flow fields were studied as a function of time. Color, white light interferograms of these flows were also obtained at exposure times of 50 nanoseconds using a recently developed Kerr cell. (auth)

40207 INVESTIGATION OF THE PHENOMENA IN CROSSED-FIELD PLASMA ACCELERATORS. M. Richard Denison and Richard W. Ziemer (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-378, 48p, $1.00. (CONF-226-6)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

The acceleration of a plasma by means of a crossed field accelerator is beset by problems that as yet do not have adequate explanations. The experimentally observed effects include the sudden drop in thrust with increasing magnetic field strength, extremely unsymmetrical electrode heating, and lack of acceleration in some closed channel accelerators. These problems also have their counterparts in MHD generators. In order to obtain a better understanding of the physical phenomena associated with J × B acceleration, an analytical and experimental diagnostic study was undertaken. A primary objective is to determine and understand the current density distribution in the discharge region. A theoretical description of the current density distribution in a constant area J × B channel was developed, including the effects of both Hall currents and ion slip. Computor solutions for several values of the Hall parameter were obtained which exhibited the physically observed characteristics of high current density concentrations at the upstream edge of the cathode and the downstream side of the anode. An experimental investigation of the phenomena occurring in a crossed-field accelerator was conducted using a confined jet-type accelerator, specifically designed and built for this basic study. The accelerator employed electrodes that were segmented transversely and longitudinally to the flow. These segments were electrically insulated but at the same potential and the current through each of the cathode and anode segments was individually measured. In addition, electrode side wall potential measurements were made. Reproducible data was obtained which indicates the magnitude and distribution of the electric field in the core of the plasma as well as the sheath potential drops on each electrode. Physical interpretations and evaluation of the observed phenomena are given and specific needs for more detailed diagnostic information are outlined. (auth)

40208 SPECTROSCOPIC MEASUREMENTS IN PLASMAS. W. K. McGregor (ARO, Inc., Arnold Air Force Station, Tenn.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-374, 33p, $1.00. (CONF-226-9)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

The possible uses of spectroscopy in the diagnostics of plasmas are described. Brief descriptions of the methods

used in measurement of temperature are given and an attempt is made to identify the governing energy distribution in each case. Identification with the translational velocity distribution makes the method valid; identification with some other distribution makes closer study necessary. Some actual data from arc plasma jets are used to illustrate the arguments. The classical criteria for equilibrium are re-examined briefly and some additional limitations imposed. The influence of metastable atoms on the interpretation of the spectra from low density streams is discussed, and some application to temperature measurement is given. (auth)

40209 PLASMA DIAGNOSTICS. Charles E. Wharton (General Atomic Div., General Dynamics Corp., San Diego, Calif.). New York, American Institutes of Aeronautics and Astronautics, 1963, Preprint 63-367, 39p, $1.00. (CONF-226-15)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

A number of interesting plasma diagnostic techniques have evolved over the last few years. Some have found wide application while others are lacking in some respect. Some measurements involve internal probing, such as Langmuir and magnetic probes, with the possibility of severely perturbing the plasma. Others are external measurements, such as microwave or optical probing and optical spectroscopy. In the latter methods the technology of the method itself is as complicated as the applications to plasma diagnostics. Other techniques are useful only in dense plasmas or in hot plasmas or in plasmas confined by an intense magnetic field. To sort out the measurements useful for a given kind of determination, a brief survey of several techniques, grouped according to the quantities measured, is given. Certain of the methods that have been extensively developed or have considerable potential are then expanded upon. (auth)

40210 SOME EXPERIMENTS IN RADIO FREQUENCY DIAGNOSTICS OF PARTIALLY IONIZED PLASMAS. R. M. Montgomery and R. A. Holmes (Purdue Univ., Lafayette, Ind.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-373, 9p, $1.00. (CONF-226-10)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

The results of the experiments performed, show that high frequency methods can be applied to measure plasma sheath thickness directly. They also show that the high frequency impedance between electrodes in a plasma can be accurately predicted and that the plasma electron density, temperature, and collision frequency can be determined from this impedance. (auth)

40211 MICROWAVE DIAGNOSIS OF A PARTLY IONIZED FLOW IN THE PRESENCE OF A MAGNETIC FIELD. Koichi Oshima (Univ. of Southern California, Los Angeles). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-386, 8p, $1.00. (CONF-226-2)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

Problems involving the interaction of electromagnetic waves with the plasma sheath surrounding a hypervelocity vehicle are gaining importance in connection with communication blackout from a space ship and radar cross section of a ballistic missile. An attempt is made to separate the various phenomena as much as possible. Electron characteristics and collision frequencies in nitrogen flow are presented. (R.E.U.)

40212 THE MEASUREMENT OF ARGON TRANSITION PROBABILITIES AND COMPUTATION OF THERMODYNAMIC PROPERTIES OF THE ARGON PLASMA. H. N. Olsen (Northrop Space Labs., Hawthorne, Calif.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-369, 9p, $1.00. (CONF-226-14)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

In order to determine the best possible values for spontaneous transition probabilities from measured absolute spectral line intensities emitted from a thermal arc plasma, it was essential that the highest accuracy be attained in the theoretical calculation of the plasma composition. Corrections must be considered in the calculation: lowering of the ionization potential, cut-off of the partition function, and Debye polarization contribution to the total pressure. The plasma composition is calculated, and the partition functions, heat content, Gibbs free energy, entropy, and constant-pressure specific heat are computed. The thermodynamic properties include the contributions from translation, ionization, internal excitation, mixing, and Debye-Hückel polarization. (R.E.U.)

40213 MEASUREMENTS OF MHD TURBULENCE WITH MAGNETIC PROBES. Robert Betchov and Eugene B. Turner (Aerospace Corp., El Segundo, Calif.). New York, American Institute of Aeronautics and Astronautics 1963, Preprint 63-372, 12p, $1.00. (CONF-226-11)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

Small magnetic probes were used to make a systematic study of MHD turbulence in a linear pinch stabilized with an initial longitudinal magnetic field. The pinch is produced in a 5 inch I.D., 24 inch long tube filled with deuterium gas by the discharge of an 85 μf capacitor bank charged to 15 kv. The stabilizing field is 2000 gauss and the gas pressure is typically 80 μHg. The small magnetic probes, with a frequency response up to 50 Mc, are inserted into the plasma through a slot in the cathode and are moved radially by traversing screws. The probe signals, which are proportional to $\dot{B}$, are integrated to give B, the magnetic field strength. Differentiating once gives $\ddot{B}$ which is a very sensitive measure of the onset and duration of the turbulence. A complete mapping of the pinch was done using the $\ddot{B}$ signal to find the onset of turbulence as a function of radius and time. The correlation between two probe signals was obtained as a function of the probe separation using a technique employing an x-y oscilloscope. One probe signal is put into the horizontal amplifier and the other into the vertical amplifier. Many shots are required to obtain a relatively smooth pattern that has an elliptical shape with the major axis lying at 45° to the horizontal. The correlation is a function of the ratio of minor to major axis of an elliptical brightness contour. (auth)

40214 MICROWAVE MEASUREMENTS OF ELECTROMAGNETIC PROPERTIES OF PLASMA FLOW-FIELDS. A. I. Carswell, M. P. Bachynski, and G. G. Cloutier (RCA Victor Co., Ltd., Montreal). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-385, 20p, $1.00. (CONF-226-3)

From 5th Biennial Gas Dynamics Symposium, Evanston, Ill., Aug. 1963.

The application of various microwave techniques to the study of plasma properties in the presence of a (supersonic) flow-field is discussed. Possible application of this study could be made to the re-entry environment, where a need exists to examine the properties of gas-dynamic flow-fields in which there is a significant degree of ionization.

The discussion is limited to laboratory facilities: the plasma tunnel, the shock tube, and the ballistic range. (R.E.U.)

40215 IMPROVEMENTS IN METHODS OF INJECTING AND TRAPPING PARTICLES IN A CONFINING MAGNETIC FIELD. (to General Dynamics Corp.). British Patent 932,802. July 31, 1963. Priority date Feb. 16, 1960, United States.

A method of obtaining charged particles in an evacuated chamber with a static magnetic confining field and no varying electric field is patented. A beam of particles is divided into discrete bunches, which are injected into the chamber at an angle to the magnetic field. The bunches become disorganized in the chamber, and particles are trapped in the field. A pair of parallel beams of particles may be used, with one of the beams divided into bunches and the average velocity of the particles in one beam exceeding that in the other beam. Plasma within the chamber may be used as one of the beams. Neutral plasma may be injected and trapped in a chamber containing a plasma by passing a beam of bunched positive ions through a cloud of electrons. (M.P.G.)

Shielding

Refer also to abstract 38622.

40216 (NAA-SR-Memo-8516(Rev.)) ANALYTIC TECHNIQUES FOR THE CALCULATION OF THE ORNL TOWER SHIELD EXPERIMENTS. PART II. ANNEX-2. R. S. Hubner (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 20, 1963. Contract AT(11-1)-Gen-8. 124p.

Program ANNEX-2 is described. It is a modified version of ANNEX-1, NAA-SR-TDR-8427. Statistical estimation and biasing techniques were included insuring that every neutron scattering event for every history contributed to the flux at the detector; thus, each neutron history not only contributes to the flux at the detector, but also contributes to several energy groups of the detector spectrum. The energy group structure is "filled up" more rapidly than in ANNEX-1 resulting in much shorter running times for the same degree of convergence. Program restrictions, operation, and input are the same as for ANNEX-1. (auth)

40217 (AEC-tr-6044) THERMAL FLUX IN SHIELDS OF GRAPHITE, IRON, CONCRETE, IRON-CONCRETE, C-CONCRETE. M. Hot, J. P. Millot, and J. Rastoin. Translated for Oak Ridge National Lab., Tenn., from report DEP/SEPP-42/60. Jan. 1960. 25p.

The results of flux measurements made on thermal reactor shields of graphite, iron, concrete, iron-concrete and C-concrete are compiled. (D.C.W.)

40218 (AEC-tr-6051) STUDY OF REFLECTION AND SCATTERING OF FAST NEUTRONS IN A WALL. J. P. Barthe (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Fontenay-aux-Roses). Translated for Oak Ridge National Lab., Tenn., from report DEP/SEPP/232/62. [nd]. 10p.

The calculation of the dose transmitted by a wall of uneven thickness is outlined for the case in which the thickest part of the wall is opposite the source. Necessary account is taken of scattering by air or the thinnest parts of the shield. The reflection of neutrons on a wall is also calculated. Further, the use of the Junon and Venus programs in a French autocode for the Ferranti Mercury computer to calculate neutron scattering through a wall and neutron reflection on a wall is considered. (D.C.W.)

40219 (AEC-tr-6058) CALCULATION OF THE EFFECTIVE CROSS-SECTION Σ OF DIFFERENT MATERIALS FOR 14 AND 3 Mev NEUTRONS. J. P. Millot and M. Hot. (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Fontenay-aux-Roses). Translated for Oak Ridge National Lab., Tenn., from report DEP-SEPP-158-61. May 1961. 4p.

The effective cross sections of concretes, Novopan (compressed wood), water, iron, and Fe–H_2O for 14-Mev neutrons were determined from the fluxes detected with and without the sample in the beam. The cross section of Novopan for 3-Mev neutrons was also measured. (D.C.W.)

40220 (AEC-tr-6063) PRACTICAL UTILIZATION OF THE PROGRAMS MANON 749/B AND CARMEN/868. J. P. Barthe (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). Translated for Oak Ridge National Lab., Tenn., from Report DEP/SEPP 246/62. Dec. 1962. 15p.

The Manon 749/B program investigates the progagation of gamma rays or fast neutrons over the axis of a disk source through a shield of up to 14 laminates. Fluxes in the interior can also be calculated for one shield at a maximum of 14 equidistant points. The Carmen/868 program calculates the doses due to the capture gamma rays produced in a shield from the thermal flux in the medium. The equations for the programs are given, and the use of the programs is described. (D.C.W.)

40221 OPTIMUM CONDITION FOR PROTECTIVE SHIELDING FROM A NUMBER OF RADIATION SOURCES. G. A. Lisochkin. At. Energ. (USSR), 15: 67-8(July 1963). (In Russian)

The change in shielding weight q due to a change in dose rate by a factor e is as follows: $q = pLS$, where p is the density of the shielding material, L is the relaxation length of the radiation, and S is the area of the shielding with a variable thickness. The relation between the dose rate f from a single source and the change in shield weight can be expressed as follows: $f = p \exp(-\chi/q)$, where p is the dose rate for a given shielding condition. The total dose rate for two sources is as follows: $P = p_1 \exp(-\chi_1/q_1) + p_2 \exp(-\chi_2/q_2)$. The minimum dose rate is to be determined, that is, the function $P(\chi_1,\chi_2)$ is to be determined for a constant shielding weight: $\phi = \chi_1 + \chi_2 = 0$. The solution is obtained by the use of Lagrange multipliers: $\chi_1 = -\chi_2 = -q_1q_2 \ln (p_1q_2/p_2q_1)/(q_1 + q_2)$. The dose rate from a given source p_i^0 and the corresponding weight factor q_i are related as follows: $(p_1^0/q_1) = (p_2^0/q_2) = \ldots = (p_n^0/q_n)$. The fractional contribution from various sources with a minimum shielding weight can be calculated for a total constant dose rate. The minimum shielding weight is determined for two sources emitting different kinds of radiation (for example, neutrons and γ quanta) with the use of two different kinds of shielding materials (for example, water and lead). (TTT)

40222 THE STRUCTURE OF THE γ-RADIATION FIELD FROM AN ISOTROPIC POINT SOURCE IN ALUMINUM WITH SLAB GEOMETRY. V. A. Vorob'ev. At. Energ. (USSR), 15: 68-70(July 1963). (In Russian)

The γ-radiation field formed by an isotropic point source (with energies of the γ-quanta E_o of 0.661, 1.0, 1.38, and 2.62 Mev) in a semi-infinite aluminum absorber at a depth H equal to 0, 0.5, 1, and 2 free path lengths of the primary radiation was calculated by a Monte Carlo method. The scattered radiation becomes negligibly small for $H > 2$. The reflected γ radiation shows a maximum peak at $E \approx 0.25$ Mev, whose size decreases linearly with

increasing angle θ from the normal. The average energy of the reflected γ quanta is $\bar{E}(E_o,\theta) \equiv 0.2\ E_o^{0.2}$ at $\theta = 0°$, and $\bar{E}(E_o,\theta) \equiv 0.5\ E_o^{0.75}$ at $\theta > 75°$. $\bar{E}(E_o) = 0.30\ \sqrt{E_o}$ with an accuracy of a few percent. The angular distribution of the total number of reflected γ quanta per unit solid angle $N(E_o,\theta)$ does not depend on the energy of the primary γ quanta and is described by the function a exp $(-\theta/75)$, with an accuracy of about 15%. The angular distribution of energy flow per unit solid angle $I(E_o,\theta)$ is close to isotropic for $\theta < 70°$ and $E_o > 2$ Mev and follows a cosine law with a decrease in the energy of the primary radiation. The total albedo is approximated by the function $R_B(E_o) = 0.41\ E_o^{-0.2}$. The spectral-angular distribution of the γ-ray intensity $I(E_o,E,\theta,H)$ is given for an isotropic point source with $E_o = 1.0$ and 2.62 Mev at a depth of 0.5, 1, and 2 free path lengths after passage through a layer of material. (TTT)

40223 GAMMA-RAY SCATTERING BY CONCRETE SURFACES. Eric T. Clarke and John F. Batter (Technical Operations Research, Burlington, Mass.). Nucl. Sci. Eng., 17: 125-30(Sept. 1963).

Gamma radiation from point sources of Co^{60} (1.25 Mev) and Ir^{192} (0.4 Mev) was scattered from a concrete surface. Dose rates were measured at heights equal to source heights, as a function of the ratio of height to separation distance. The percent of scattered to direct radiation rises to a maximum of 12% at h/d = 0.10 for Co^{60}, and a maximum of 20% at h/d = 0.15 for Ir^{192}. These results are shown to agree with other work and with Monte Carlo calculations. (auth)

40224 PRAKTISCHE DURCHFÜHRUNG VON ABSCHIRMUNGS-BERECHNUNGEN. (Practical Realization of Shielding Calculations). Karl-Heinz Lindackers. Munich, Verlag Karl Thiemig KG, 1962. 106p.

The theoretical principles and calculation methods for gamma, neutron, and beta shielding are considered. The equations for calculations and results for material characteristic shielding values are given. Results are presented in graphs and tables and characteristic calculations are illustrated. (M.C.G.)

40225 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. John Rennie Griffin and Walter Robert Turk (to United Kingdom Atomic Energy Authority). British Patent 934,242. Aug. 14, 1963. Filed June 26, 1961.

A liquid radiation shield for a neutron source is patented. A container for liquids is located between the source and the radiation facility. The container is filled from a supply tank with liquid having a large neutron absorption cross section when the source is to be shielded and emptied when the source is to be used. The supply tank is higher than the shielding container, so that the shielding container is filled from the supply tank by gravity in the event of pump failure. (M.P.G.)

Theoretical Physics

40226 ROLE OF THE OBSERVER IN QUANTUM THEORY. Abner Shimony (Massachusetts Inst. of Tech., Cambridge). Am. J. Phys., 31: 755-73(Oct. 1963).

In quantum theory as it is currently formulated the measurement of an observable quantity of a physical system is the occasion for a change of state of the system, except when the state prior to the measurement is an eigenstate of the observable. Two proposals for interpreting this kind of change are examined in detail, and several variant proposals are considered briefly. According to the interpretation proposed by von Neumann, and by London and Bauer the change of state is completed only when the result of the observation is registered in the observer's consciousness. Although this interpretation appears to be free from inconsistencies, it is not supported by psychological evidence and it is difficult to reconcile with the intersubjective agreement of several independent observers. According to the interpretation proposed by Bohr, the change of state is a consequence of the fundamental assumption that the description of any physical phenomenon requires reference to the experimental arrangement. Bohr's proposals are valuable as practical maxims in scientific activity, but they are shown to involve the renunciation of any ontological framework in which all types of events — physical and mental, microscopic and macroscopic — can be located. It is concluded that a satisfactory account of the observation of microphysical quantities is unlikely if the present formulation of quantum theory is rigorously maintained. (auth)

40227 GEOMETRICAL DEMONSTRATION OF VELOCITY TRANSFORMATION IN SPECIAL RELATIVITY. Scott C. Daubin (General Motors Corp., Santa Barbara, Calif.). Am. J. Phys., 31: 792-801(Oct. 1963).

The relativistic velocity transformation is demonstrated by a graphical representation of a thought experiment using a moving rod containing a moving element. In the frame in which the rod is at rest, the moving element is observed to possess a certain velocity; the requirements of the theory are then applied to present graphically a series of events which determine the velocity of the moving element in the frame in which the rod is in motion. (auth)

40228 ON THE RELATIVISTIC FORMULATION OF THE MAXWELL EQUATIONS. K. A. Haemeen-Anttila. Ann. Acad. Sci. Fennicae, Ser. A VI, No. 120, 1-20(1963). (In English)

The relativistic Maxwell equations are written in a mathematically equivalent new form that closely resembles the ordinary form of the three-dimensional Maxwell equations of magnetic field. This new formalism, which in no way changes the physical content of the equations, is extended also for crystals and applied on a comparison between the behavior of electromagnetic field in matter and in general relativistic gravitational field. (auth)

40229 MEASUREMENTS IN QUANTUM MECHANICS. Henry Margenau (Yale Univ., New Haven). Ann. Phys. (N. Y.), 23: 469-85(Sept. 1963).

A review of customary theories of the measurement process exposes certain conceptual and empirical difficulties. They arise in connection with the uncertainty principle, the projection postulate in its usual understanding, and in an attempt to formulate joint probabilities for noncommuting observables. These difficulties are analyzed and clarified. Suggestions are then made for their avoidance by establishing a more rigorous, less ambitious, but wider definition of the meaning of a quantum measurement; a meaning which takes a single measurement to be a nonpredicative event in a stochastic ensemble, an event from which the complete state of the system under observation can in general not be inferred. (auth)

40230 GRAVITATIONAL WAVES. W. G. Bonnor (Univ. of London). Brit. J. Appl. Phys., 14: 555-62(Sept. 1963).

There are several similarities between general relativity and classical electromagnetism, and these lead to the question whether gravitational waves, like electromagnetic waves, have a real existence. Fundamental difficulties, due to the covariant nature of general relativity, arise in

definition of a gravitational wave. The two contemporary approaches to the problem are reviewed. The more physical method is to ask whether the waves carry energy, or, what is the same thing, whether a radiating source loses mass. No exact solutions of the field equations are available to answer this question, so approximation methods are used. From these it is found that some sources do emit physical gravitational waves; but so far it is not known whether freely gravitating systems, such as the solar system, lose energy or not. The more mathematical approach is to construct certain invariants characterizing gravitational radiation. The vast amount of work done on this subject in the last six years is briefly reviewed. Though mathematically interesting, the results are physically indecisive. The review concludes with a brief account of experimental work on gravitational waves and states some outstanding problems. (auth)

40231 ON THE RAINICH GEOMETRIZATION OF SCALAR MESON FIELDS. K. Kuchar (Charles Univ., Prague). Czech. J. Phys., 13: 551-7(1963). (In English)

Similarly as in the Rainich geometrization of an electromagnetic field, a system of differential equations is found for the metric tensor, equivalent to the equations of the gravitational and scalar meson field. It is shown how to find the wave function of the meson field if the Ricci tensor is known. (auth)

40232 A REPUDIATION OF SPECIAL RELATIVITY AND A SUGGESTED ALTERNATIVE THEORY. S. Smith. Nucl. Energy, 280-3(Oct. 1963).

It is proposed that the theory of special relativity must be discarded, and an alternative theory is suggested that contains only the conservation of mass. The fundamental Lorentz transformation is considered and several criticisms of its validity are discussed. A derivation of the basic formula $E = mc^2$ from the uncertainty principle is given, and implications and objections to this derivation are discussed. Several tests of the new theory are also suggested. (C.E.S.)

40233 ON ISOBARIC SPIN SPACE. H. Froehlich (Univ. of Liverpool). Nucl. Phys., 45: 609-31(Aug. 1963). (In English)

A previously proposed treatment of reflexions as special cases of continuous transformations is developed in detail by a method based on the introduction of 3-dimensional structures (triads). The requirement of Lorentz invariance of the definitions of an unreflected and a fully reflected state of a triad can be fulfilled only if from a relativistic point of view a triad has axial symmetry only. Rotations round the symmetry axis are Lorentz invariant processes. The development of the formalism leads to the introduction of a 4-dimensional space with (nearly) Euclidean properties. All its operations find interpretations in terms of local structures in physical space. Lorentz invariant operators are found that have exactly the properties of isospin operators and thus lead to an interpretation of isospace. One of its main characteristics is its axial symmetry which can be extended to spherical symmetry in a limited way only. The well known cases arise; they have only one common Lorentz invariant operator, corresponding to the electric charge operator. (auth)

40234 REPRESENTATIONS OF PARAFERMI RINGS. C. Ryan and E. C. G. Sudarshan (Univ. of Rochester, N. Y.). Nucl. Phys., 47: 207-11(Aug. 1963). (In English)

The operator algebra corresponding to a system consisting of an arbitrary finite number v of parafermi oscillators is considered with a view to obtaining all irreducible representations of the operator algebra defining it. It is shown that this algebra is isomorphic to the Lie algebra of the orthogonal group B_ν in $2\nu + 1$ dimensions. The known results of the representation theory of the orthogonal group are then used to find the representations of the ring of parafermi operators. In particular it is seen that the so-called Green ansatz for a parafermi ring arises in a natural way and that, in a certain sense, it furnishes the most general solution of the parafermi algebra. The case of a parafermi ring of order 2, which is the simplest nontrivial case, is considered in some detail. (auth)

40235 DIAGRAM TECHNIQUE AND REGGE POLES. G. Domokos (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., 47: 235-40(Aug. 1963). (In English)

A modified isobar approximation is proposed, in which the isobar is described by means of a Regge pole. Rules are established to calculate Feynman diagrams containing Regge poles. Most properties of usual diagrams, in particular, the prescription for calculating imaginary parts remain valid for these generalized diagrams. (auth)

40236 PERTURBATIVE EXPANSIONS OF REGGE-POLE TRAJECTORIES FOR YUKAWA POTENTIAL. M. Cassandro (Università, Rome), M. Cini, G. Jona-Lasinio, and L. Sertorio. Nuovo Cimento (10), 28: 1351-74(June 16, 1963). (In English)

Starting from an asymptotic equation satisfied at large momentum transfer by the scattering amplitude for Yukawa potential, an exact equation for the determination of Regge pole trajectories is obtained, and the connection with other methods is clarified. This equation is then solved explicitly for the so-called leading trajectory by constructing perturbative expansions. Two power series are given, one valid when the energy is very large and the other when the energy is exactly zero. Finally, the threshold behavior is discussed in detail and the reasons for the breakdown of perturbative expansions in this region are exhibited. (auth)

40237 SCATTERING IN TWO DIMENSIONS. R. W. Lardner (Columbia Univ., New York). Nuovo Cimento (10), 28: 1375-87(June 16, 1963). (In English)

A model theory is considered in which space-time consists of two dimensions. The scattering amplitude is derived in the two-particle approximation, up to certain ambiguities. Conditions on the coupling strength are obtained in order that the solution should not have unwanted bound states. It is shown that the model satisfies Levinson's theorem and certain properties of the resonances are established. (auth)

40238 ON THE QUANTIZATION OF CLASSICAL SYSTEMS. J.-P. Amiet (Universität, Bonn). Nuovo Cimento (10), 29: 69-91(July 1, 1963). (In English)

It is proven that no quantization rule can be invariant under all canonical transformations of the classical variables p and q. The maximum invariance of a quantization rule is determined. (auth)

40239 ON REGGE POLES IN QUANTUM ELECTRODYNAMICS. H. Salecker (CERN, Geneva). Nuovo Cimento (10), 29: 92-102(July 1, 1963). (In English)

The question is examined as to what extent an explicit treatment of the photon, the electron, and the muon as Regge poles (in the technical sense of not being connected with quantized fields) is still possible or already excluded by the existing experimental and theoretical evidence. It is found that the slope of the photon trajectory introduced through a reggeization of quantum electrodynamics is, according to the existing experiments, at least one order of magnitude smaller than the slope of the vacuum trajectory

in strong interactions. Due to insufficient experiments, the present limits for the slopes of the electron and muon trajectories are only of the same order as the slope of the vacuum trajectory. A number of suitable experiments are proposed to lower these limits. (auth)

40240 RELATIVISTIC THEORY OF MOTION IN THE EXTERNAL FIELD FOR A SYSTEM WITH INTERNAL DEGREES OF FREEDOM. V. G. Nevzglyadov (Leningrad State Univ.). Nuovo Cimento (10), 29: 118-47(July 1, 1963). (In English)

The Lorentz-covariant theory of motion in an external field is developed for a mechanical system with 12 degrees of freedom: 3 translational, 3 rotational, and 6 deformation degrees. The system is called a relativistically homogeneous deformation body. The theory is a generalization of a previously published theory for the homogeneous deformation body, which is a generalization of the absolute solid body. In the way M. Born and Herglotz set the problem of giving the Lorentz-covariant form to the theory of solid motion, the rotational degrees of freedom disappeared and the solid body of the relativistic theory could move only translationally. The problem is set in a more generalized way and includes in the solution a relativistic top as a special case. The developed equations were analyzed and the first integrals of motion were obtained. The quantum theory was built as a generalization for internal degrees of freedom of the Schrödinger relativistic equation and the Dirac equation. The possibility of the existence of the particle's classical spin commuting with the quantum spin was found. As an example an evaluation of the value of the proton magnetic momentum is provided. (auth)

40241 THE VACUUM STATE IN QUANTUM FIELD THEORY. H. J. Borchers, R. Haag, and B. Schroer (Univ. of Illinois, Urbana). Nuovo Cimento (10), 29: 148-62 (July 1, 1963). (In English)

It is shown that in a local quantum field theory, which describes zero-mass particles, the existence of a vacuum state is neither derivable from nor contradicted by the field equations and commutation relations that define the theory. It is an independent postulate that can be added for convenience or left off without changing the essential physical content of the theory. (auth)

40242 DO MAGNETIC MONOPOLES VIOLATE PARITY? N. Pintacuda (Scuola Normale Superiore, Pisa, Italy and Scuola di Perfezionamento in Fisica Nucleare, Pisa, Italy). Nuovo Cimento (10), 29: 216-23(July 1, 1963). (In English)

A logical analysis is undertaken on the meaning of the statement of parity conservation for magnetic monopoles. A comparison is made with similar classical situations. A twofold meaning of parity arises from the discussion, and a group-theoretical method is employed in order to define a weak and a strong parity. Such a distinction applies to more general invariances. (auth)

40243 REGGE TRAJECTORIES IN THE WEAK-COUPLING LIMIT. A. Bastai (Università, Turin), L. Bertocchi, and M. Tonin. Nuovo Cimento (10), 29: 247-55(July 1, 1963). (In English)

The relation between the asymptotic behavior of the potential in momentum space and the limits of the Regge trajectories in the high-energy limit is investigated both for the nonrelativistic theory and for the multiperipheral model. It is found that the limit of the dominant Regge trajectory is $-\beta$ for a potential whose asymptotic form is $g^2 s^{-\beta}$. (auth)

40244 ON BORCHERS' SECOND THEOREM. S. Doplicher (Università, Rome). Nuovo Cimento (10), 29: 285-7(July 1, 1963). (In English)

It is shown how Borchers' theorem, stating the identity of the S matrices that are associated with every local relativistic field theory, is interpolated by different fields in the same locality class. The S matrices are unitary if the postulate of completeness of asymptotic states is introduced. (R.E.U.)

40245 ON POSSIBLE OBSERVABLE EFFECTS OF SINGULARITIES ON THE LEFT HALF-PLANE Re $l < -1$. T. Yoshimura (Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Nuovo Cimento (10), 29: 291-4(July 1, 1963). (In English)

Some consequences of the meromorphy in the half-plane Re $l < -\frac{1}{2}$ are investigated without assuming the Mandelstam representation, and observable effects of singularities on the left half-plane are found. Restriction to the domain of meromorphy within the right half-plane is because of the infinitely many singularities of kinematic origin on the line Re $l = -\frac{1}{2}$. (R.E.U.)

40246 SELF-CONJUGATE GRAVITATIONAL FIELDS. [PART] I. S. R. Roy and L. Radhakrishna (Banaras Hindu Univ., Varanasi, India). Proc. Roy. Soc. (London), Ser. A, 275: 245-56(Sept. 24, 1963).

By splitting the curvature tensor R_{hijk} into three 3-tensors of the second rank in a normal co-ordinate system, self-conjugate empty gravitational fields are defined in a manner analogous to that of the electromagnetic field. This formalism leads to three different types of self-conjugate gravitational fields, termed as types A, B, and C. The condition that the gravitational field be self-conjugate of type A is expressed in a tensor form. It is shown that in such a field R_{hijk} is propagated with the fundamental velocity and all the fourteen scalar invariants of the second order vanish. The structure of R_{hijk} defines a null vector, which can be identified as the vector defining the propagation of gravitational waves. It is found that a necessary condition for an empty gravitational field to be continued with a flat space-time across a null 3-space is that the field be self-conjugate of type A. The concept of the self-conjugate gravitational field is extended to the case when $R_{ij} \neq 0$ but the scalar curvature R is zero. The condition in this case is also expressed in a tensor form. The necessary conditions that the space-time of an electromagnetic field be continued with an empty gravitational field or a flat space-time across a 3-space were obtained. It is shown that for a null electromagnetic field whose gravitational field is self-conjugate of type A, all the fourteen scalar invariants of the second order vanish. (auth)

40247 IRREDUCIBLE REPRESENTATIONS OF THE "UNITARY SYMMETRY" GROUP. D. L. Pursey (Univ. of Glasgow). Proc. Roy. Soc. (London), Ser. A, 275: 284-94 (Sept. 24, 1963).

A systematic study is made of the irreducible representations of the unitary unimodular group in three dimensions, an algebraic technique being used that is based on the well-known theory of the rotation group in three dimensions. Explicit representation matrices are found. The representations are characterized by the ranges of the hypercharge and isobaric spin that occur in them. The dimension formula is derived and the invariants are determined. Two identities are found relating the generators of the group. (auth)

40248 REGULAR PERTURBATION AND ASYMPTOTIC LIMITS OF OPERATORS IN QUANTUM FIELD THEORY.

Yusuke Kato and Nobumichi Mugibayashi (Kobe Univ., Japan). Progr. Theoret. Phys. (Kyoto), 30: 103-33(July 1963). (In English)

In the framework of the theory of regular perturbation asymptotic operators in quantum field theory are defined by means of a strong convergence in the Hilbert space. The fixed source theory and the boson-fermion system with extended interaction are particularly concerned. It is proved that adjusted annihilation and creation operators satisfy the equations of motion in differential as well as in integral forms and tend, at remote times, toward their asymptotic limits that have the same physical contents required in the axiomatic quantum field theory. It is also shown that the commutation relations between these asymptotic operators and the total hamiltonian are of the same form as those between free operators and the free hamiltonian. This gives definite information on the spectrum of the total hamiltonian. As an example Lee's hamiltonian with recoils is analyzed. (auth)

40249 THE THEORY OF SMALL-ANGLE MULTIPLE SCATTERING OF FAST CHARGED PARTICLES. William T. Scott (Univ. of Nevada, Reno). Rev. Mod. Phys., 35: 231-313(Apr. 1963).

A systematic unified review is given of the basic statistical theory of the multiple scattering of fast charged particles in the small-angle range. The approximation considered is that of the Snyder-Scott-Molière theory, and only slight attention is given to the less accurate Gaussian approximation. The single-scattering formulas of Molière are derived, along with the modifications of them given by Nigam, Sundaresan, and Wu. Molière's multiple-scattering calculation is presented by an improvement of Bethe's method, and the work of Nigam is given by the same method with newly computed tables. Snyder's calculations are outlined, and previously unpublished work on spatial-angle scattering is reported with tables. Calculations by Keil, Zeitler, and Zinn for very thin films are given, as well as a detailed discussion following Lenz on scattering at very small angles. The work of Mühlschlegel and Koppe on the multiple scattering of polarized electrons is included, with the important correction that no depolarization appears in the approximation to which they worked. The distributions of lateral deflections and other characteristics are considered, but the details of applications to emulsions, cloud and bubble chambers, etc, are not entered into, nor are the electron-penetration and path-length problems handled. Asymptotic formulas for relatively large angles are treated, as are various types of mean values. (auth)

40250 TIME MEASUREMENTS IN ACCELERATED FRAMES OF REFERENCE. J. E. Romain (General Dynamics, Fort Worth, Tex.). Rev. Mod. Phys., 35: 376-89 (Apr. 1963).

The results of an investigation into the relation between the time measurements performed in an inertial frame and in an accelerated frame are presented. A wholly kinematic and not a gravitational scheme is used in this study of accelerated frames in empty space-time. (R.E.U.)

40251 INTERNATIONAL SYMPOSIUM ON ATOMIC AND MOLECULAR QUANTUM MECHANICS PROCEEDINGS AT SANIBEL ISLAND, 14-19 JANUARY, 1963. Rev. Mod. Phys., 35: 421-733(July 1963).

The international symposium held at the University of Florida in January 1963 included atomic and molecular calculations, electronic structure and statistical theory of atoms, the Hartree-Fock approximation, atomic spectra, spin resonance and hyperfine splitting, molecular integrals, molecular spectra, conjugated systems, intermolecular forces, chemical reactivity, chemical bonds, symmetry properties, perturbation theory and reaction operators, and subjects in biophysics and biochemistry. Of the 42 papers presented, separate abstracts were prepared for 8 papers and one was previously abstracted for NSA. (R.E.U.)

40252 ELIMINATION OF ATOMIC ERRORS FROM MOLECULAR CALCULATIONS. A. C. Hurley (Ames Lab., Ames, Iowa). Rev. Mod. Phys., 35: 448-56(July 1963). (IS-620)

The intra-atomic correlation correction method (ICC) arose because the analytic orbitals for optimum parameter values differ significantly from atomic and ionic Hartree-Fock functions and because the intra-atomic correlation energy is much more than the dissociation energy for the molecules. An analysis of ICC calculations is presented for H_2 and HeH^+. (R.E.U.)

40253 NONADIABATIC THEORY FOR DIATOMIC MOLECULES AND ITS APPLICATION TO THE HYDROGEN MOLECULE. W. Kolos (Univ. of Chicago) and L. Wolniewicz. Rev. Mod. Phys., 35: 473-83(July 1963).

The electronic-vibrational wave functions are obtained from the Schrödinger equation for the relative motion of the electrons and nuclei in a diatomic molecule. Numerical computation for the ground state of the hydrogen molecule is carried out. (R.E.U.)

40254 INTERPRETATION OF THE RAPID CONVERGENCE OF CORRELATED WAVE FUNCTIONS. T. L. Gilbert (Argonne National Lab., Ill.). Rev. Mod. Phys., 35: 491-4(July 1963).

The effect of correlation on the functional form of the wave function pertaining to the structure of the Coulomb hole is presented. The advantages of the correlated wave function for the description of the Coulomb hole over the superposition of configurations are discussed. (R.E.U.)

40255 ON THE SPATIAL CORRELATION OF ELECTRONS IN THE GROUND STATE OF HELIUM. Gilbert Munschy and Philippe Pluvinage (Institut de Physique, Strasbourg). Rev. Mod. Phys., 35: 494-6(July 1963).

In the ground state of helium the greatest part of the electronic repulsion is taken into account by giving to the nucleus an effective charge such that each electron moves independently in a screened Coulomb central field. The wave function is then a product of two exponentials, the variables being only the distances of the two electrons from the center of forces. The results of the correlation of the wave functions for helium are presented. (R.E.U.)

40256 IMPORTANCE OF CORE POLARIZATION ON THE CALCULATION OF NUCLEAR MOMENTS FROM HYPERFINE STRUCTURE DATA. NUCLEAR MOMENTS OF C^{11}. N. Bessis, H. Lefebvre-Brion, and C. M. Moser (Centre de Mécanique Ondulatoire Appliquée, Paris). Rev. Mod. Phys., 35: 548-51(July 1963).

The values of the magnetic moments for B^{11}, C^{11}, O^{17}, and F^{19} are obtained from the average values of the magnetic field of the electron, which were previously calculated. The importance of core polarization is shown in the determination of the nuclear magnetic moment. (R.E.U.)

40257 PROPERTIES OF FERMION DENSITY MATRICES. Tsuyoshi Ando (Indiana Univ., Bloomington). Rev. Mod. Phys., 35: 690-702(July 1963).

An investigation is presented of basic properties of

fermion density matrices and their importance in quantum chemistry. An advanced study of properties of the first-order density matrices and the general properties of higher-order ones is presented. (R.E.U.)

40258 WAVE AND REACTION OPERATORS IN THE QUANTUM THEORY OF MANY-PARTICLE SYSTEMS. Per-Olov Löwdin (Univ. of Florida, Gainesville and Uppsala Univ.). Rev. Mod. Phys., 35: 702-9(July 1963).

The interrelation between the split-orbital method, the method using a correlation factor containing the interparticle distances, and the method of superposition of configurations is shown for many-electron systems. The modern treatment of the many-particle problem based on the concepts of wave and reaction operators is discussed. (R.E.U.)

40259 GENERALIZED PERTURBATION THEORY IN OPERATOR FORM. H. Primas (Swiss Federal Inst. of Tech., Switzerland). Rev. Mod. Phys., 35: 710-12(July 1963).

It is proposed to formulate any quantum mechanical perturbation theory in operator form and to take advantage of the fact that such a theory can be completely formulated in the domain of a Lie algebra. The concept of a T-operator is generalized and used to compose a solution of a complicated quantum mechanical problem from subproblems connected therein. (R.E.U.)

REACTOR TECHNOLOGY

General and Miscellaneous

Refer also to abstracts 38996, 39289, 39380, 39954, and 39975.

40260 (ANL-5800(2nd Ed.)) REACTOR PHYSICS CONSTANTS. (Argonne National Lab., Ill.). July 1963. Contract W-31-109-eng-38 . 876p.

This second edition is based on data available on March 15, 1961. Sections on constants necessary for the interpretation of experimental data and on digital computer programs for reactor design and reactor physics have been added. 1344 references. (D.C.W.)

40261 (APDA-155) STUDY OF FAST REACTOR MELTDOWN ACCIDENTS USING SIMULANT MATERIALS. Paul R. Huebotter (Atomic Power Development Associates, Inc., Detroit). Aug. 31, 1963. Contract AT(11-1)-865. 107p.

A study was carried out on meltdown accident conditions in a sodium-cooled fast reactor fueled with U-alloy pin-type elements. Dynamic mockup tests were performed using lead and water in place of U alloy and sodium, respectively, and electrical resistance heating to simulate fission heating. The conditions of power and coolant flow (pressure drop) leading to meltdown, and the distribution of melted fuel were studied. The following conclusions were reached: At low pressures characteristic of liquid-metal-cooled reactors, the pressure drop increases sharply in the coolant two-phase regime. Flow stability requires the following inequality at the intersection point of the supply and demand pressure drop-flow curves: $(dP/dW)_{supply} < (dP/dW)_{demand}$. The critical flow rate and pressure drop can be calculated. Fuel meltdown occurs when the supply pressure falls below the demand pressure at the critical flow rate. The fuel initially moves away from the core midplane and tends to flow as a slurry rather than as a slug. (D.L.C.)

40262 (BNL-7293) SOME PROBLEMS IN THE INTERPRETATION OF EXPONENTIAL EXPERIMENTS. Robert L. Hellens and Eigil Andersen (Brookhaven National Lab., Upton, N. Y.). Aug. 16, 1963. Contract AT-30-2-GEN-16. 43p. (SM/42/28; CONF-133-35)

From International Atomic Energy Agency Symposium of Exponential and Critical Experiments with Calculations, Amsterdam, Sept. 1963.

Buckling measurements at BNL employed two experimental methods (flux shape and variable loading) that in principle should yield identical results, but in practice show a systematic and significant discrepancy. The experimental evidence of these errors is reviewed, and their source is traced by means of theory to the radial flux transients that perturb the asymptotic neutron spectrum in the exponential assemblies. Some alternate and apparently more precise methods of analyzing the data are examined theoretically, including the possibility of anisotropy in the leakage probability. (auth)

40263 (CONF-243-1) OPERATIONAL PHYSICS DATA FROM THE HWCTR. B. C. Rusche (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Sept. 20, 1963. Contract AT(07-2)-1. 9p.

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The Heavy Water Components Test Reactor is described; and rod worths, temperature coefficients, and flux shapes measured at low power are compared with calculated values. The experimental procedures and calculations are discussed. (D.C.W.)

40264 (EUR-375.d) SCHLINGERSTAND ZUR PRÜFUNG VON BAUELEMENTEN FUR SCHIFFSREAKTOREN. (Rolling-Stand for the Testing of Marine Reactor Components). D. Ulken (Gesellschaft fur Kernenergieverwertung, Hamburg). 1963. 28p.

The influences of sea motions and machine vibration cause additional high stresses on the structural members of a ship reactor. To achieve the required high safety in operation, it is necessary to test new constructions prior to their installation in a ship. It is intended to make sure that the function of control rod drives and instruments and the durability of control rods and fuel elements undergo thorough testing on a so-called rolling stand. This test-stand is able to simulate ship motions both at sea and in case of accidents. The design and first experience with the rolling stand are described. (auth)

40265 (EURAEC-603) RESULTS OF BURNOUT AND INSTABILITY EXPERIMENTS ON A 7-ROD BUNDLE UP TO 30 ATMOSPHERES PRESSURE-FIRST SERIES WITH ZERO INLET SUBCOOLING AND NATURAL CONVECTION. Special Technical Report No. 4. C. L. Spigt (Eindhoven, Netherlands. Technische Hogeschool). Feb. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 032-60-11-RDH. 59p.

Burnout and instability experiments were carried out at saturation temperatures of 140, 180, 200, and 230°C on a 7-rod bundle test section simulating a Halden Boiling Water Reactor II fuel element. In these experiments the inlet subcooling was virtually zero and the water velocity determined by natural circulation. Two methods were used to obtain high enough heat fluxes to test burnout without at the same time increasing channel power. In the first method one of the rods was more highly rated than the other six and contained "hot patches." In the second, the rods were equally heat-rated but hot patches of higher heat flux ratio were used to obtain the necessary heat flux to test burnout. Runs were made in which the predicted reactor axial heat flux profile was approximated by uniform heat flux with superimposed peaks of hot patches. The results of these experiments can be summarized as follows: (1) The pressure drop across the inlet holes of the shroud + bottom spacer was measured as 4.0 and 6.2 velocity heads respectively. (2) The maximum in the flow rate versus power curve occurs at 60, 120, 150, and 170 kw respectively at 140, 180, 200, and 230°C. The maximum inlet velocity at 230°C was about 0.85 m/sec. The negative slope of the curve beyond the maximum decreases with increasing pressure. (3) Instabilities in flow were detected. At 140°C they started at about 290 kw and at 180°C at about 300 kw, considerably above the power at which the maximum velocity occurs. The oscillations started quite suddenly with a period of about 0.5 to 0.8 seconds. At 200 and 230°C no such indication was obtained up to the powers tested of 420 and 480 kw respectively. (4) The hot patches were made by machining the outside of the rod to give a local reduction in OD. The channel power at which burnout occurred for a patch with sharp

edges was significantly lower than a streamlined one for the same operating conditions. (5) Disregarding the runs made with hot patches with sharp edges, burnout at 200 and 230°C was only obtained under stable flow conditions, whereas at 140 and 180°C burnout was obtained at respectively 350 and 460 kw in unstable flow conditions. The observations made suggest that the position of the burnout point and the conditions under which burnout occurs are governed by a different mechanism in stable and in unstable flow. (6) It was found consistently, that in the cases where stable flow burnout occurred, it did so at the upper of two equally rated hot patches. The highest heat flux obtained in the hot patches was 280 w/cm^2 at 200°C and 260 w/cm^2 at 230°C. (7) An explanation of the results obtained at 200 and 230°C could be given by assuming: (a) that in the low quality region the burnout heat flux increases with increasing quality. (b) burnout heat flux decreases with increasing test section length. Both effects have been reported in the literature. (8) From the results obtained in two runs at 230°C there is an indication that an outer rod is more dangerous than an inner one. When the loop has been modified by the introduction of a subcooler, a second series of experiments will be made, to assess the effect of inlet subcooling. In these tests, internal hot patches and equally heated rods will be used and burnout and instability data obtained with radial flow symmetry. (auth)

40266 (EURAEC-728) DEVELOPMENT PROGRAM ON THE APPLICATION OF STEAM–WATER SPRAY TO REACTOR COOLING. CAN-3—Quarterly Progress Report No. 6, April 1 to June 30, 1963. (Centro Informazioni Studi Esperienze, Milan). July 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 056-62-1-RDI. 13p. (CISE-R-81)

Heat transfer experiments were pursued in the large scale Genoa loop. Two tubular test elements were tested, of 2.5 and 1.5 cm ID respectively. It was possible to heat successively different sections of the test element. The general trend of the results obtained in the smaller Piacenza loop was confirmed: both the inverse effect of specific mass flow rate on critical heat flux at high qualities and the inlet instability at inlet qualities about zero were verified. A third test element was manufactured having an isokinetic probe located just after the exit end of the heated section. The in-pile experiments performed in the report period were the following: a) measurement of the amount of hydrogen produced in the loop due to radiolysis; b) chemical control of water in the loop. In-pile corrosion experiments on Zircaloy-2 were initiated and a shielded cell was assembled for handling the irradiated specimens. Specimens subjected to static corrosion tests were analyzed to determine hydrogen pick-up. (auth)

40267 (EURAEC-750) AN ADVANCED RESEARCH PROGRAM ON THE APPLICATION OF STEAM–WATER SPRAY TO THE COOLING OF LIGHT WATER REACTORS. CAN-2 Quarterly Progress Report No. 8, April 1–June 30, 1963. (Centro Informazioni Studi Esperienze, Milan). July 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 060-61-7RDI. 13p. (CISE-R-80)

During the quarterly report period, heat transfer experiments were mainly devoted to measure critical heat flux in a three-rod cluster and in annuli. Due to the bending of the heated rods at the crisis, during these experiments several test sections were seriously damaged. The spacers seem to have a strong influence on the location first affected by the crisis and on the value of the critical power. An improved annular test element is being designed. Anyway 200 burnout points were measured with three rod clusters and annuli. Experiments on pressure drops and on critical heat flux were performed at different pressures with tubular test elements. Hydrodynamic studies were pursued with the adiabatic loop at room temperature and circular test sections. The measurements of phase and velocity distribution in the region close to the wall with argon-water mixtures were completed. The effect of surface tension was investigated. Pressure drops together with phase and velocity distribution in the core and in film region, were measured using ethyl alcohol as the liquid phase. Design is in progress for an apparatus capable of measuring the total liquid hold-up in the test section through liquid level variations in a reservoir. A cluster test element was also constructed and is now ready to be inserted in the loop. Corrosion experiments were carried out on Zircaloy-2 specimens in presence of controlled oxygen content in the steam-water mixture. Experiments with different specific mass flow rates were pursued. A new set of tests was initiated in autoclave in accelerated conditions of corrosion on samples of different types and geometry. (auth)

40268 (EURAEC-775) RESULTS OF FLOW-RATE MEASUREMENTS ON A 7-ROD BUNDLE UP TO 30 ATMOSPHERES PRESSURE WITH INLET SUBCOOLING AND NATURAL CONVECTION. Special Technical Report No. 5. J. F. Tummers and Th. H. Spanjers (Eindhoven, Netherlands. Technische Hogeschool). June 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 032-60-11-RDH. 35p.

Flow-rate measurements on a seven-rod-bundle test section, whose geometry was very close to a Halden Boiling Water Reactor second charge fuel element were carried out for 140°C (3.7 atm), 180°C (10.2 atm), 200°C (15.9 atm) and 230°C (28.5 atm) with inlet subcooling very close to zero. For 140°C the measurements were also carried out with 30 and 60 kw subcooling and for 230°C at 50 kw subcooling. The rods were heated electrically (d-c) and connected in parallel to give equal heat rating of the rods. For safety one of the outer rods had a hot patch, which was obtained by machining the outside of the tube wall so that the increased electrical resistance produced a locally high heat flux. The method of operating was to stabilize the system at the required pressure and subcooling for different power and taking measurements of power, velocity, and temperatures at several places in the circuit. During these experiments the stability of the channel was checked by means of the signal of a differential pressure gage and a burnout detector. From the results of these experiments the steam quality and the nonboiling length were determined. (auth)

40269 (EURAEC-798) HEAT TRANSFER AND STABILITY STUDIES IN BOILING WATER REACTORS. Report WW016-R49. Quarterly Progress Report No. 10, May 1, 1963–July 1, 1963. (Eindhoven, Netherlands. Technische Hogeschool). Work Performed under United States–Euratom Joint Research and Development Program. Contract 032-60-11RDH. 23p.

Adversities encountered have given some delay in the experimental programme. Due to fluctuations present in the main power, it was impossible to reach a steady state condition necessary for taking measurements and making recordings. The development of the radioactive method for void fraction measurement was successfully completed. The reproducibility of the void fraction measurement in the pressurized boiling loop is at stable conditions better than

±1% void. The impedance method under development will be applied in the next series of experiments. No experiments could be made with the pressurized loop due to difficulties with the power supply and the loop itself. In the atmospheric boiling loop, pictures were taken of the instabilities present. The theoretical studies were continued. From the recirculation calculations, some interesting results were obtained. The theoretical study based on first principles was finished and reported. (auth)

40270 (GEAP-4240) FUEL ELEMENT EXPERIMENTS IN SADE-VBWR NUCLEAR SUPERHEAT LOOP. C. N. Spalaris, W. R. Raymont, M. F. Lyons, T. F. Evans, R. F. Boyle, T. B. Murdock, and N. D. Weiss (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). May 1963. Contract AT(04-3)-189. 125p.

Three irradiation experiments are described, which were designed to study the behavior of fuel elements in a reactor superheated steam environment. The experiments were conducted in the Superheat Advanced Demonstration Experiment (SADE) loop, Vallecitos Boiling Water Reactor. The results obtained demonstrated that 304 stainless steel fuel clad is unsatisfactory for use in nuclear superheat fuel sheath designs where plastic strain or plastic deformation is allowed to occur. The results were in agreement with those reported for a previous experiment in SADE (SH-4B), and constituted the basis for change in direction of the superheat fuel program in regard to both design and fuel sheath selection. (auth)

40271 (GEAP-4301) FUEL CYCLE PROGRAM. A BOILING WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report No. 12, April–June 1963. C. L. Howard, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 5, 1963. Contract AT(04-3)-189. 46p.

Fuel irradiations in the VBWR have resulted in exposure increases of 1200 to 1500 Mwd/t for the lead assemblies of each type. Preliminary tests in the hydraulic stability loop using sinusoidal oscillation of power input show that each test condition has more than one resonance frequency and that the resonance frequency is dependent on the test condition. A revised noise analysis code named DART was used to obtain the reactivity noise spectrums for natural circulation operation of VBWR. Burnout tests with an axial heat flux variation in both a cosine and truncated cosine distribution show that the results can be predicted to ±10% by calculations based on uniform heat flux data. The calculation involves determination of local quality and heat flux along the test heater and comparison of these values to the previously determined correlation of burnout heat flux with local conditions. Thus, it is shown that burnout depends primarily on the local heat flux, quality, and flow conditions, and not the shape of the flux distribution. Data for pressure drop in a test section having a rough liner to increase the critical heat flux show that the values are reasonable to consider for reactor application. All previous results from the heat transfer task are summarized. (N.W.R.)

40272 (JPL-TR-32-333) ANALYSIS OF HETEROGENEOUS REACTORS CONTAINING MODERATING FUEL ELEMENTS. André Jacques Tesnière (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Feb. 28, 1963. Contract NAS 7-100. 22p.

The Feinberg-Galanin method for heterogeneous reactors is formulated by using a two-group model rather than an age kernel. This treatment is then extended to take into account secondary effects, such as fast fission and thermalization of neutrons inside a rod which may contain moderator. The use of a single coefficient in a Feinberg-Galanin approach allows one to relate the source and sink strength of the fuel element to the thermal flux only. By defining a set of four coefficients, it is possible to connect the strengths of thermal- and fast-neutron sources and sinks to both thermal and fast fluxes. A method is presented for calculation of these four coefficients, α_1, β_1, α_2, and β_2. (auth)

40273 (NAA-SR-Memo-8675) A THREE ATOM REPRESENTATION OF FISSION PRODUCT POISONS. M. W. Halseth (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 25, 1963. Contract [AT(11-1)-Gen-8]. 15p.

Fission products were lumped together either into fast, slow, and non-burning elements or into a non-burning element and samarium-149. These elements were then used in burnup studies of two reactors. The results were compared with similar results obtained by experiment or by different formulations of fission product elements. (auth)

40274 (NYO-9672) EVALUATION OF GAS–GRAPHITE SUSPENSIONS AS NUCLEAR REACTOR COOLANTS. Final Report. G. P. Wachtell, J. P. Waggener, and W. H. Steigelmann (Franklin Inst. Labs. for Research and Development, Philadelphia). Aug. 1961. Contract AT(30-1)-2512. 81p. (F-A2392-02)

A survey was made of experimental and theoretical work pertaining to the use of a suspension of graphite particles in a gas as a nuclear reactor coolant. Following a general review of the state-of-the-art and a detailed study of recent experimental data, it was concluded that present theory and experimental data are encouraging but inadequate as a basis for reactor design. Especially lacking are both theoretical and experimental work defining the hydrodynamic and thermal requirements for preventing the plating-out of the solids from the suspension. Future work is recommended in which the stability of suspensions receives primary attention. Supporting parallel studies of basic theory, erosion, effects of nuclear radiations, and compatibility of materials, as well as development of specialized instrumentation and plant components, are also recommended. These would then be followed by experimental heat transfer and pressure drop studies to obtain correlations for reactor design applications. (auth)

40275 (ORNL-TM-690) FEASIBILITY STUDY OF MEASUREMENT OF NEGATIVE REACTIVITY BY ANALYSIS OF NEUTRON FLUCTUATION SPECTRAL DENSITY. C. W. Ricker, A. L. Colomb, and E. R. Mann (Oak Ridge National Lab., Tenn.). Sept. 27, 1963. Contract W-7405-eng-26. 16p

A preliminary experiment was performed by use of the Bulk Shielding Reactor (BSR) to determine the feasibility of measuring the negative reactivity by analyzing the neutron density fluctuations of a reactor, and the possibility of making these measurements in a relatively short time by making simultaneous measurements of the spectral densities in several fixed-frequency intervals within a specific frequency range. Measurements were made using direct filtering, squaring, and time-averaging of the amplified signal from an ionization chamber. From these data, reactivities were calculated and compared with reference reactivities for five conditions of subcriticality. Approximately 80% of the experimental data points were within ±30% of reference reactivities. At three of the five subcritical conditions, the experimental reactivities agreed well with reference reactivities. Small negative reactivities

were measured within a factor of 2 of the reference reactivities within minutes by use of simple and inexpensive equipment. (auth)

40276 (PG-Report-173(Rev.)) CALDER TYPE REACTOR COOLANT: ANALYTICAL REQUIREMENTS AND PROBLEMS. R. W. Dickinson, E. Hughes, A. R. Newcombe, R. C. Williams, and F. J. Woodman (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1963. 15p.

An outline is given of the methods used in the analytical control of carbon dioxide feed gas in Calder Hall type reactors. Examination of the circuit gas is described, the techniques including mass spectrometry, infrared analysis, and carbon-14 counting. The radioactive species in the coolant are also studied and a gas chromatographic method for the determination of the rare gas fission product isotopes is described. (auth)

40277 (TID-7024) NUCLEAR REACTORS AND EARTHQUAKES. (Lockheed Aircraft Corp., Palo Alto, Calif. and Holmes and Narver, Inc., Los Angeles). 1961. 415p.

A book is presented which supplies pertinent seismological information to engineers in the nuclear reactor field. Data are presented on the occurrence, intensity, and wave shapes. Techniques are described for evaluating the response of structures to such events. Certain reactor types and their modes of operation are described briefly. Various protection systems are considered. Earthquake experience in industrial and reactor plants is described. (D.L.C.)

40278 (TID-7648(Pt.I)) TRIPARTITE ORGANIC COOLED HEAVY WATER REACTOR MEETING, SANTA MONICA, CALIFORNIA, JUNE 11-13, 1962. (Atomic Energy of Canada Ltd., Chalk River, Ont.; European Atomic Energy Community; and Atomic Energy Commission, Washington, D. C.). 248p.

Twenty-two papers presented at the Tripartite Organic Cooled Heavy Water Reactor Meeting at Santa Monica, California, June 11 to 13, 1962, are given. Topics covered include: Canada's organic-cooled reactor program, organic-cooled reactor program in U. S., heat transfer and burnout studies, OCDR coolant tube assembly development, fuel for organic-reactors, development of materials for an OCDR, zirconium alloys in organics, fuels and fuel cladding for organic reactors, developments in organic-coolant studies, report on Standards and Advisory Committee of the U. S. Organic Reactor Working Group, search for new coolants and reclamation of coolants, theoretical studies on liquid coolants, organic decomposition studies and analytical chemical development at AECL, fouling on fuel surfaces, WR-1 station data, Heavy Water Components Test Reactor, Plutonium Recycle Test Reactor, PIQUA Nuclear Power Facility and PDPR, Experimental Organic Cooled Reactor, computer program for economic studies of heavy-water power reactors, fuel assembly design program (FAD), and optimization of heavy-water power reactors. (M.C.G.)

40279 (TID-19028) INTERACTION IN ARRAYS—A COMPARISON OF THEORY AND EXPERIMENT. H. K. Clark (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). [1963]. Contract AT(07-2)-1. 13p. (CONF-39-42)

From American Nuclear Society 9th Annual Meeting, Salt Lake City, June 1963.

A simple method for computing the interaction in a critical grouping of units, each of which would be subcritical if isolated from the others, is reviewed. Calculations by this method are compared with experimental results for reflected and unreflected cubic arrays with various numbers of units. (D.C.W.)

40280 (UCRL-6901) ROOM TEMPERATURE CRITICAL MEASUREMENTS ON THORIUM-LOADED, GRAPHITE-MODERATED, ORALLOY-FUELED SYSTEMS. G. M. Benson and R. H. Fox (California. Univ., Livermore. Lawrence Radiation Lab.). June 30, 1962. Contract W-7405-eng-48. 29p.

The comparison of uranium-235 fueled, graphite-moderated critical assemblies with and without thorium is critically studied. The assembly for the experiment consisted of a lattice of thin oralloy fuel foils regularly spaced between 0.5- and 1-inch-thick graphite moderator blocks stacked in horizontal planes. Additional foils of thorium were procured having the same dimensions as the oralloy foils. The experimental procedure was simply to restack some of the previously reported uranium-235-graphite assemblies with the addition of thorium foils at regular intervals and to determine the new critical height. Thus, part of the fast leakage of neutrons in the uranium-235-graphite core is replaced with resonance absorption by the thorium. Comparison shows that the thermal spectra agree to $\frac{1}{2}\%$. 3% less neutrons reach thermal in the thorium-loaded case. In this case, the flux is higher in the intermediate energy range because of the reduced leakage. As a result, uranium absorption is increased slightly. (N.W.R.)

40281 (UJV-905/63) O PŘECHODOVÝCH STAVECH REAKTORU PŘI VÝMĚNĚ ČLÁNKU. ČAST 2. VÝMĚNA S KONSTANTNÍ REAKTIVITOU. (Compensation in Reactors During Replacement of Fuel Elements. Part 2. Replacement with Constant Reactivity). V. Bartošek (Československá Akademie Věd. Ústav Jaderného Vyzkumu, Řež). 1963. 12p.

Conditions for reactor fuel reloading without loss of reactivity were studied. An analytical expression was found for the reactivity coefficient as a function of burn up. Under given conditions certain parts of the fuel elements were over exposed and excessive reactivity losses were encountered. This condition was corrected by a mixed loading in which equilibrium was reached during first charge removal. (R.V.J.)

40282 (UJV-921/63) O PŘECHODOVÝCH STAVECH REAKTORU PŘI VÝMĚNĚ ČLÁNKU. ČAST 3. VÝMĚNA S ÚSPOROU ZÁSOBY REAKTIVITY. (Compensation in Reactors During Replacement of Fuel Elements. Part 3. Replacement Without Loss of Reactivity). V. Bartošek (Československá Akademie Věd. Ústav Jaderného Vyzkumu, Řež). 1963. 15p.

Studies were made of economical reactor first and second fuel charge operations without excessive loss of reactivity. (R.V.J.)

40283 (WAPD-TM-312) PLASTIC-SASS—A COMPUTER PROGRAM FOR STRESSES AND DEFLECTIONS IN A REACTOR SUBASSEMBLY UNDER THERMAL, HYDRAULIC, AND FUEL EXPANSION LOADS. C. M. Friedrich (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). May 1963. Contract AT-11-1-GEN-14. 61p.

PLASTIC-SASS, an ALTAC-3 computer program that determines stresses and deflections in a flat-plate, rectangular reactor subassembly is described. Elastic, plastic, and creep properties are used to calculate the results of temperature, pressure, and fuel expansion.

Plate deflections increase or decrease local channel thicknesses and thus produce a hydraulic load which is a function of fuel plate deflection. (auth)

40284 (AEC-tr-6060) EVOLUTION OF GAMMA FLUX DURING A POWER OVERRUN IN A LIGHT WATER REACTOR. C. Girard and M. Hot (France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). Translated for Oak Ridge National Lab., Tenn., from report DEP/SEPP/CAB/03/63. Feb. 1963. 14p.

The use of gamma flux measurements as a measure of reactor power is hampered by the gamma rays from fission products. Gamma flux calculations were made for a power overrun in a swimming-pool reactor of the Cabri type. Prompt, fission, and capture gamma rays were considered. It is shown that the fission gamma rays are attenuated more rapidly than the prompt gamma rays and become negligible at a distance of more than 3 m from the core. Hence, an ionization chamber can be used to measure the prompt gamma flux as a measure of the reactor power. (D.L.C.)

40285 (AEC-tr-6066) CALCULATION FOR A SECONDARY SHIELD. J. P. Barthe (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Fontenay-aux-Roses). Translated for Oak Ridge National Lab., Tenn., from report DEP/SEPP/156/61. May 1961. 9p.

The calculation of the dose at a point due to a number of point sources (in a reactor) is outlined. The effect of the reactor umbra is considered, and the calculation of the shield thickness traversed using the appropriate subprogram is outlined. (D.C.W.)

40286 (EURAEC-696) HYDRODYNAMIC INSTABILITIES LIMITING THE POWER OF BOILING WATER REACTORS. Quarterly Report No. 4, January 15, 1963–March 15, 1963. (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). Work Performed under United States–Euratom Joint Research and Development Program. Contract 076-61-12RDF. 39p. (A translation)

Perfect continuity between the instability phenomena in natural and forced convection with by-pass is verified. It therefore appears that the only influence of the outer loop is to impose a pressure and a temperature at the inlet of the channel and a difference in pressure between its extremities. The experimental study of the area in forced convection in the neighborhood of natural convection brought out many onsets of instability with a given power and piezometric load. This peculiarity may be in correlation with the recondensation in the riser. It is verified that the S shape curve had no effect on the existence of instability. The calculation of the S shape curves of channel CF_4 was effected and verified experimentally. It will be noted that the phenomenon of vaporization by expansion which was taken into consideration in the calculation may be explained by a resurgence of the channel characteristic (loss of pressure in relation to flow at given inlet power and temperature) which may, at high rates, differ from the characteristic in liquid phase. (N.W.R.)

40287 THE DISTRIBUTION OF NEUTRON COUNTS FROM A DETECTOR PLACED IN A REACTOR. V. G. Zolotukhin and A. I. Mogil'ner. At. Energ. (USSR), 15: 11-16(July 1963). (In Russian)

It is assumed that a reactor is subcritical and that a steady-state power level is maintained by an external neutron source having an intensity of S neutrons/sec with a Poisson distribution of emitted neutrons. The following probability functions for the production of neutrons are assumed: (1) $H(\chi)$ for the number of neutrons in the reactor at any arbitrary time (at steady state); (2) $F_1(\chi_1,\chi_2,t)$ for the number of neutrons in the reactor at time t and for the number of neutrons counted with a time interval of t with the assumption that there is one neutron in the reactor at t = 0; (3) $P(\chi,t) = F_1(1,\chi,t)$ for the number of neutrons counted within a time interval of t due to the single neutron in the reactor at t = 0; and $\Pi_t(\chi)$ for the number of neutrons counted within a time t. Mathematical expressions are derived for these probability functions, which were experimentally confirmed by determining the value of α (a measure of the background noise in a reactor) by the probability method and by the method of Cohn (Nucl. Sci. and Eng., 5: 331(1959)). An accuracy of 5% was obtained in 8 minutes with the use of the P_0-method ($\alpha = 420 \pm 20$ sec^{-1}), while an accuracy of only 12% was obtained in 80 minutes by the use of Cohn's method ($\alpha = 400 \pm 50$ sec^{-1}). It was found that the negative reactivity up to at least $\sim 10\beta$ ($\alpha_0 = \beta/l_0$ and l_0 is the average life-time of the neutron) could be measured by the probability method, if it is assumed that α is related to the reactivity ρ by the following linear relation: $\rho/\beta = (\alpha/\alpha_0) - 1$. A six-channel, transistorized statistical analyzer and an enriched BF_3 neutron detector were used in making the measurements by the probability method. (TTT)

40288 THE EFFICIENCY OF A SYSTEM OF ABSORPTION RODS ARRANGED ARBITRARILY IN A REACTOR CONTAINING A REFLECTOR. V. I. Nosov. At. Energ. (USSR), 15: 71-4(July 1963). (In Russian)

The general problem for an arbitrary arrangement of absorption rods in a reactor is solved by a two-group approximation. The fast neutron flux ϕ_1 and slow neutron flux ϕ_2 are expressed in matrix form. With a cylindrical reactor containing a system of absorption rods arbitrarily arranged in a radial reflector, the series sum equations contain terms such as the number of rods N, the order number of the rod i, r which is the distance from the center of the reactor to an arbitrary point P, ρ_i which is the distance from the center of the rod with number i to the point P, ϕ and ω_i which are the azimuthal angles, and subscripts referring to the active zone and to the reflector, respectively. A system of $2N(2k + 1)$ linear algebraic equations (here k is the order of the approximation, and usually k = 0) can be obtained, and the criticality condition is derived by setting the determinant of these equations equal to zero. (TTT)

40289 CONTROL OF A RUN-AWAY REACTOR BY ANALYSIS OF ITS TIME PERIOD. A. R. Mirzoyan and I. N. Brikker. At. Energ. (USSR), 15: 74-6(July 1963). (In Russian)

In the ideal case, the neutron flux of a reactor with a given period τ_0 varies exponentially: $n_1(t) = n_0 \exp t/\tau_0$, where n_0 is the initial neutron flux. However, in the case of a run-away reactor, the time period τ deviates from the given τ_0 due to a variation in the excess reactivity ρ about a value ρ_0. An expression for ρ can be written in the form of a sum of two parts, a stationary part ρ_0 and a variable part $\Delta\rho$: $\rho(t) = \rho_0 + \Delta\rho(t)$. With $\rho(t) = \rho_0$, the following solutions can be obtained: $n(t) = n_1(t)$ and $C(t) = C_1(t)$. On introducing the deviation from this solution, that is, $n = n_1(1 + \delta n)$ and $C = C_1 + \Delta C$, it is possible to obtain a solution for the transmission function of a run-away reactor: $W(s) = \delta n(s)/\Delta\rho(s)$. Here s is a Laplace operator. A block diagram for stabilizing the period of a reactor uses an output signal which is proportional to $1/\tau$ to control the reactivity of the reactor. This method can be used to re-

place nonlinear methods of simulating the reactor kinetics. Well-known methods of analyzing the period of a reactor can be used. (TTT)

40290 MEASUREMENT OF HIGH ANTIREACTIVITIES OF A SUB-CRITICAL NUCLEAR REACTOR BY RANDOM PULSE SOURCE EXCITATION AND INTERCORRELATION. Jean Valat. Compt. Rend., 257: 891-4(July 22, 1963). (In French)

The excitation of a sub-critical nuclear reactor by a neutron source with rectangular pulses with height 2S and width b, appearing in a Poisson manner, permits the determination of the antireactivity by intercorrelation between the excitation and the response of the reactor. (tr-auth)

40291 CONTROL AND SAFETY OF NUCLEAR REACTORS. Ludwig Merz. Dechema Monograph., 43: 331-46 (1962). (In German)

Methods of manual and automatic control of nuclear reactors are discussed from the standpoint of safety and permissible periods. Methods to prevent runaway and unnecessary scram are considered. A survey of devices such as interlock switches and warning and scram systems is given. The tasks and scope of nuclear measuring channels with regard to automatic control and reactor safety are discussed. The possibility of breakdown and modes of operation in the safety apparatus are also reported. (auth)

40292 EFFICIENCY OF CENTRAL CONTROL ROD PARTIALLY INSERTED INTO THE CYLINDRICAL REACTOR. PART I. Fumio Amano. Denki Shikensho Iho, 27: 182-92(Mar. 1963). (In Japanese)

A method is described for a calculating the efficiency of the control rod and the flux distribution in the vicinity of the rod, when the control rod is partially inserted into a bare cylindrical reactor and a reflected reactor. This method is an extension of Nordheim-Scalettar's Method and introduces the axial flux harmonics as well as the radial flux harmonics. The one-group and two-group diffusion equations are used to solve various problems together with the special boundary conditions at the surface of the control rod. The value of minimum buckling B^2_m and the corresponding flux distribution $\phi(r,z)$ are calculated, and then the relations between the reactivity and flux peaking along the surface of the control rod are also calculated by this method. (auth)

40293 CRITICAL EQUATION OF REACTOR. II. ON THE NEUTRON TEMPERATURE. Satoshi Nagayama. Denki Shikensho Iho, 27: 271-7(Apr. 1963). (In Japanese)

A critical calculation was carried out on a D_2O reactor according to the same theory concerning a critical equation of a reactor that uses the eigen cross sections as is given in a previous report, and the validity of this theory was demonstrated. These results are compared with results obtained by other methods that use the effective cross section. It was concluded that this method is superior to other ones from the viewpoint of the accuracy of calculation and the length of the time required for the calculation. (auth)

40294 CALCULATION OF A MULTIPLYING SYSTEM CONSISTING OF 90% ENRICHED URANIUM, WATER AND ALUMINIUM. A. Ascari and J. Vajra (SORIN, Centro Ricerche Nucleari, Saluggia, Italy). Energia Nucl. (Milan), 10: 359-67(July 1963). (In Italian)

The multiplication factor and other significant quantities were computed for an infinite multiplying medium consisting of 90%-enriched uranium, light water, and aluminum. The medium is assumed homogeneous, but the results can be referred to heterogeneous close-spaced systems (MTR type fuel elements). Allowances for non-thermal contributions to the multiplication were made. (auth)

40295 ANALYSIS OF A Lu-ACTIVATION EXPERIMENT FOR NEUTRON TEMPERATURE MEASUREMENT. F. Accinni and G. B. Zorzoli (Laboratori CISE, Milan). Energia Nucl. (Milan), 10: 368-74(July 1963). (In English)

An experimental determination of the neutron temperature in a fuel element of the Boris Kidrič Institute RB reactor is described. The results were compared with a theoretical determination, based on two different models. The maximum precision attainable in a single measurement, performed in similar conditions, is also discussed. (auth)

40296 A METHOD FOR THE STUDY OF LOCAL FLUX DISTORTIONS IN A HETEROGENEOUS REACTOR. S. Gallone and G. Ghilardotti (AGIP Nucleare, Milan). Energia Nucl. (Milan), 10: 413-22(Aug. 1963). (In English)

A method is described to evaluate the local flux distortions in a heterogeneous reactor. The method, derived from the Feinberg-Galanin heterogeneous method, is based on the consideration that the flux at a point is mainly determined by the neighboring rods. Therefore, it is not necessary, if only the knowledge of the flux within a small region is required, to apply the Feinberg-Galanin method to the whole multiplying system. Only the contribution from the neighboring rods are calculated using the Feinberg-Galanin method, while the remaining contribution from the remote rods are more roughly evaluated by a homogenization. Explicit formulas are given in the two-group approximation for plane and cylindrical geometry. The numerical examples carried out so far, in plane geometry, show good agreement with the results of a full heterogeneous treatment of the whole multiplying system. (auth)

40297 PLUTONIUM AS REACTOR FUEL. M. A. Rollier (Universita, Pavia, Italy). Energia Nucl. (Milan), 10: 442-51(Aug. 1963). (In Italian)

A lecture on the use of plutonium as reactor fuel, delivered at the Federazione Associazioni Scientifiche e Tecniche of Milan in January 1963 is given. (auth)

40298 STABILITY CRITERIA FOR A NONLINEAR REACTOR CONTROL SYSTEM. L. Beltracchi (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-10: No. 4, 30-46(Sept. 1963).

The stability criteria for a nonlinear reactor control system is developed. The control system contains two nonlinearities; an on-off relay and gear backlash. A describing function for the nonlinearities is generated in terms of shim rate, relay deadband, and gear backlash. The describing function is then used to generate the stability criteria. (auth)

40299 THE CONTRIBUTION TO THE STABILITY ANALYSIS OF CONTROL CIRCUIT OF A COLD REACTOR WITH THE INTENTION TO HEAVY WATER REACTORS. Pavel Štirský (Inst. of Power Engineering, Prague). Jaderna Energie, 9: 245-51(1963). (In Czech.)

A method is described of determining the stability region in a reactor control circuit approximated with the aid of two groups of delayed neutrons on the level of proportional and integral regulator parameters. The influence of the regulator time constant and the mean life of prompt neutrons on the stability region was investigated. The linear asymptotic approximation of the stability region and its mean error are mentioned. The stability region approximation for a reactor kinetics with two groups of delayed

neutrons was used to derive a linear approximation for a reactor kinetics with m groups of delayed neutrons. Also investigated is the influence of the approximation of the reactor kinetics on the stability region. (auth)

40300 COLLISION PROBABILITIES IN SUPERLATTICES. K. Kiesewetter (VEB Entwicklung and Projektierung Kerntechnischer Anlagen, Berlin). Kernenergie, 6: 376-81(Aug. 1963). (In German)

The collision probabilities in the various components of the superlattice were calculated from the distribution of the entering or emerging neutrons on the rod edges. (M.C.G.)

40301 CADARACHE — PROTOTYPE REACTOR CENTRE. Nucl. Eng., 8: 324-5(Sept. 1963).

A description of the prototype reactor center at Cadarache is given along with the capabilities of its different installations. The Pégase fuel-element-testing, swimming pool reactor is described. (R.E.U.)

40302 REACTOR FUEL. 1. PRODUCTION — EXPERIENCE GAINED — FUTURE OUTLOOK. 2. DEVELOPMENT — THERMAL REACTOR ELEMENTS. 3. RESEARCH — FAST REACTOR ELEMENTS. 4. REPROCESSING. Nucl. Eng., 8: 331-8(Sept. 1963).

Various phases in the reactor fuel industry in France are discussed. The needs of the growing programs in reactor uses in France are reviewed along with solutions and planned solutions. Phases discussed are production, development, research, and reprocessing. (R.E.U.)

40303 RESONANCE ABSORPTION AND THE RESONANCE DISADVANTAGE FACTOR. S. Iijima (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 17: 42-6(Sept. 1963).

The origin of the so-called resonance disadvantage factor was investigated from the point of view of the incomplete recovery of the flux at off-resonance energies and the decrease in the surface flux due to the failure of the narrow resonance approximation in the moderator. The flux recovery was studied by age theory for a typical rectangular lattice of the uranium in graphite and the effect upon the absorption by the 6.7-ev resonance of U^{238} was found to be of the order of magnitude of 2% or less. The second problem was studied by solving for the space-energy flux by iteration. Sizeable corrections were found to be necessary for the low-lying resonances of U^{238} in graphite. An approximate analytical formula was presented for this correction. (auth)

40304 INITIAL CONVERSION RATIOS AND FAST FISSION FACTORS IN HEAVY-WATER NATURAL-URANIUM LATTICES USING 19-ELEMENT UO_2 FUEL RODS. B. G. Chidley, T. J. Manuel, and P. R. Tunnicliffe (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Sci. Eng., 17: 47-54(Sept. 1963).

A previously described experimental method of determining initial conversion ratios in reactor lattices is improved. Measurements were made on D_2O-cooled, 19-element UO_2, heavy-water lattices at pitches of 18, 21, 24, 28, and 36 cm. The initial conversion ratios obtained were 0.9547 ± 0.0086, 0.8578 ± 0.077, 0.7671 ± 0.0069, 0.7416 ± 0.0067, and 0.6853 ± 0.0062 and the resonance escape probabilities derived are 0.8226, 0.8656, 0.9104, 0.9228, and 0.9511, respectively. The fast fission factors obtained for the 18, 24, 28, and 36 cm lattice pitches were 1.0283, 1.0265, 1.0253, and 1.0247. (auth)

40305 A GENERAL METHOD FOR EVALUATING THE EFFECTS OF UNCERTAINTIES IN DESIGN VARIABLES ON CORE THERMAL PERFORMANCE. A. C. Nelson, Jr. (Research Triangle Inst., Durham, N. C.), and W. S. Minkler. Nucl. Sci. Eng., 17: 101-10(Sept. 1963). (WAPD-T-1103(Rev.))

A general method was developed for evaluating the effects of uncertainties in design variables on the ability of a core to meet various transient and steady-state limiting thermal criteria. The performance characteristics of interest are evaluated by digital computer at carefully selected points in the parameter regions of interest, and the results are fitted by least squares to a polynomial approximation. Statistical information and/or limiting values may be readily applied to this approximation to yield a bound on the probability that the thermal design limits will not be exceeded. (auth)

40306 SYMMETRY PROPERTIES OF SOME EIGENFUNCTIONS OCCURRING IN REACTOR ANALYSIS. Mark Goldsmith (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 17: 111-24(Sept. 1963). (WAPD-T-1572)

A number of problems in reactor analysis require the determination of the second largest reactor eigenvalue. If one limits himself to a one-velocity description of neutron diffusion, this eigenvalue and the corresponding eigenfunction may be determined by familiar methods. When (as is almost universally the case) one must consider more than one energy group of neutrons, the neutron diffusion equations are no longer self-adjoint and the customary analysis yields information only about the eigenfunction of largest eigenvalue. The symmetry properties of reactor eigenfunctions were applied to the calculation of the first few reactor eigenvalues. Each reactor has geometrical symmetry elements that enable one to define what is known as the symmetry group of the reactor, and the transformations of the reactor under the elements of this group enable one to determine the degeneracy and symmetry properties of the reactor eigenfunctions. After a detailed review of the necessary group theoretical fundamentals, the eigenfunctions of a reactor with a trigonal control element are investigated and the adaptation of an existing diffusion theory code to the computation of higher reactor eigenvalues discussed. (auth)

40307 RADIAL BUCKLING MODES NEAR THE SOURCE OF AN EXPONENTIAL COLUMN. Curtis G. Chezem (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 17: 165-6(Sept. 1963).

The solution of the Helmholtz wave equation for a homogeneous cylindrical exponential column is given. The radial flux distribution in a natural uranium column was observed by foil activation techniques, and a computer program was used to determine three modes of this distribution. (R.E.U.)

40308 METHODS OF MEASURING TEMPERATURE IN NUCLEAR REACTORS. William E. Browning, Jr. (Oak Ridge National Lab., Tenn.). Progr. Nucl. Energy, Ser. IV, 5: 1-54(1963).

The safe operation of high-power nuclear reactors depends upon the accurate measurement of temperatures of their components. Temperature measurement devices are affected by nuclear radiation, heat flux, and other conditions which exist in nuclear reactors. Thermocouples are used in reactors more than other methods because of their small size, remote output and relative insensitivity to radiation. Theoretical considerations suggest that the effects of radiation other than transmutation on thermocouples should not be large and this is borne out by experiment. Changes in composition of thermocouples by transmutation alter their calibration. Chromel-Alumel is affected

to only a small degree; alloys containing iridium, rhodium, tungsten, or rhenium may be affected grossly. Applications of thermocouples to special problems in reactors are discussed. Other methods of temperature measurement are reviewed. Resistance thermometers are large and affected by radiation and by heat flux. Radiation pyrometers are affected by internal gamma heat or by radiation damage to optical components. Thermistors are seriously damaged. The substitution for temperature by the concept integral $kd\theta$ is discussed for fuel element interiors. Temperature measurement by differential expansion, sound velocity, diffusion, and by pneumatic probes is reviewed. Insulation materials are damaged by nuclear radiation. Ceramic or binder-free silica glass fiber insulation performs well in reactors. It is concluded that most requirements for measuring reactor temperatures can be met by selected thermocouples and insulators. Other methods are of interest for special applications. (auth)

40309 HIGH-TEMPERATURE REACTOR FUELS WITH FISSION PRODUCT RETENTION CHARACTERISTICS. M. J. Higatsberger (Osterreichische Studiengesellschaft für Atomenergie GmbH, Vienna). Radex Rundschau, No. 3, 486-93(1963). (In German)

The Metallwerke Plansee A. G., Reutte, and the Reactor Center Seibersdorf are collaborating in the scope of the Dragon contract on the production of sintered uranium–thorium carbides, their spherodization and covered with a film as well as on the preliminary experiments with this product. The research and development program of the Österreischische Studiengesellschaft für Atomenergie Ges. m. b. H. (SGAE) also comprises investigations of uranium oxide, studies of the fuel matrix, and parametric work regarding the conception of the reactor piles, also radiochemical studies of the diffusion of uranium–thorium and their fission products. The most important parameters of the production of uranium–thorium–carbide and the film-clad oxide–fuel particles are described, together with the results of tests regarding fission products and the reaction of fuels at high temperatures and variable burn up. (auth)

40310 DEVELOPMENT OF UNCANNED GRAPHITE REFLECTOR ELEMENTS FOR POOL REACTORS. Franz S. Holzer (AMF Atomics, Inc., New York). Res. Reactor J., 3: No. 4, 10-13(1963).

Graphite reflector elements are needed for maximum flexibility in the operation of pool reactors. The uses and nuclear characteristics of graphite reflector elements are outlined. The unsatisfactory performance of previous reflector elements is reviewed. A new graphite reflector element was developed which comprise blocks of impervious graphite encased in a perforated aluminum basket. Results are presented of static water absorption tests and irradiation tests. The 1 wt % water take-up in the uncanned element increases the neutron absorption by 20 to 25% as compared to a canned element, but this disadvantage is outweighed by the greater reliability of the uncanned elements. (D.L.C.)

40311 EXPERIMENTAL STUDY ON TEMPERATURE OVERSHOOT AND DELAY TIME OF TRANSIENT BOILING. Shigenori Hayashi, Tetsuo Iwazumi, Jiro Wakabayshi, Akira Sakurai, Hideto Aoki, and Motohiko Kitamura. Tech. Rept. Eng. Res. Inst., Kyoto Univ., 8: 1-12(Mar. 1963).

As a fundamental experiment to survey the mechanism of transient nucleate boiling on the surface of the fuel plate at a time when the water-cooled-moderated type reactor suddenly acquires reactivity, a metal foil was put in stagnant water and heated with electric current adjusted stepwise. Guided by the results of this experiment, a method was found of predicting the amount of the temperature overshoot, which is seen at the start of transient nucleate boiling, as well as the delay time of the process, in the functions of the velocity of the surface temperature rise of the exothermic element. Such results can improve accuracy in the analysis of reactor kinetics at the time of runaway. (auth)

40312 PREPARATION OF FUEL ELEMENTS FOR NUCLEAR REACTORS IN GERMANY. G. Matz (NUKEM, Nuklear-Chemie und -Metallurgie GmbH, Wolfgang, Ger.). Umschau Wiss. Tech., 63: 511-16(Aug. 15, 1963). (In German)

A review is given of the fuel fabrication program in Germany. The factors used in the selection of the type of fuel element are described briefly. Then typical fuel fabrication procedures and the fuel characteristics are outlined to show the preparation of rods, oxide powders, plates, and spheres. (J.S.R.)

40313 REACTOR MATERIALS. Volume 6, No. 3. R. W. Dayton, E. M. Simons, and R. W. Endebrock (Battelle Memorial Inst., Columbus, Ohio). Aug. 1963. 79p. $0.55(GPO) (Domestic), $0.70(GPO) (Foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC). 79p. (TPR-RM-Vol. 6, No. 3)

Information obtained from worldwide literature on reactor materials is reviewed. Properties, behavior, and fabrication processes of materials applicable to nuclear reactor components and associated equipment are covered under the following topics: fuel and fertile materials, moderator materials, nuclear poisons, cladding and structural materials, and special fabrication techniques. (M.C.G.)

40314 EVALUATION OF ERRORS IN LEAKAGE TESTS OF NUCLEAR PLANT CONTAINERS CARRIED OUT WITH THE COMPENSATION CHAMBER METHOD. A. Calori (CNEN, Rome) and A. Persano. Vienna, International Atomic Energy Agency, 1963, Preprint Paper CN-15/14, 22p. (CONF-69-15)

From Conference on Operating Experience with Power Reactors, Vienna, June 1963.

The method used for leakage tests consists of placing inside the container a hermetically sealed compensation chamber of small dimensions in comparison with the container, and of interconnecting chamber and container through a differential manometer. The evaluation of the errors that can arise in the leakage determination is presented. (R.E.U.)

40315 PRESSURE TUBE REACTOR. (to General Nuclear Engineering Corp.). British Patent 933,510. Aug. 8, 1963. Priority date Sept. 7, 1960, United States.

The design of a pressure-tube reactor, with the tubes in one plane at an angle to the tubes in another plane, is patented. The design is particularly well adapted to D_2O- or graphite-moderated reactors. The tubes contain fuel elements and coolant and extend through the moderator tank. They are in a plurality of juxtaposed parallel planes, the ones in each plane being parallel to and spaced from each other. The tubes in some of the planes are placed at an angle, preferably 90°, to the tubes in other planes, so that the ends of the tubes extend through different parts of the moderator tank and are laterally displaced from each other. This provides easier access to the tube ends. (M.P.G.)

40316 IMPROVEMENTS RELATING TO NUCLEAR REACTOR REFUELLING ARRANGEMENTS. John Ormerod Pounder and Eric Watson (to United Kingdom

Atomic Energy Authority). British Patent 934,221. Aug. 14, 1963. Filed Oct. 28, 1960.

A method of removing a fuel element from the core of a power reactor is patented. A carrier is passed through the wall of the reactor vessel to a position immediately adjacent to the fuel element's exit from the core. The element is withdrawn from the core, totally immersed in liquid contained by the carrier, and moved by the carrier to a disposal point. The same grab of a charging machine may be utilized for removing the fuel element and transporting the carrier. For vertically oriented fuel elements immersed in a pool of liquid coolant, an open-topped carrier may be passed through a top wall of the reactor vessel and filled with coolant by submersion, while the fuel element is transferred to the carrier beneath the surface of the pool. (M.P.G.)

40317 SPECIMEN SUPPORT FOR USE IN A NUCLEAR REACTOR. (to European Atomic Energy Community (Euratom)). British Patent 934,343. Aug. 14, 1963. Priority date July 20, 1961, Belgium.

A specimen support, which can be assembled with a tubular fuel element, is patented. The support consists of a specimen tube, means within the tube to hold the specimen and circulate cooling fluid, and means outside of the tube to hold the tubular fuel element around the specimen tube. The specimen tube and fuel element may then be loaded into the reactor as a unit. (M.P.G.)

40318 REACTOR FUEL ELEMENT CHARGING MACHINE. (to Commissariat à l'Energie Atomique). British Patent 934,471. Aug. 21, 1963. Priority date June 22, 1961, France.

A mechanical device for operating the fuel magazine of a fuel-element-charging machine is patented. The charging machine consists of a cylindrical chamber with top and bottom openings, which can be sealed off by plugs, and a fuel magazine or drum, which rotates within the chamber to line up the fuel housings with the chamber openings. The drum is operated by two coaxial ring gears, one integral with the drum and the other mounted to rotate freely. When the gear train between the gear on the drum and the motor is interrupted to immobilize the drum, the second gear moves the plugs to open or close the chamber openings. (M.P.G.)

40319 AN IMPROVED HIGH-PRESSURE VESSEL CONSTRUCTED OF PRE-STRESSED CONCRETE. Alan James Harris (to Robert McAlpine & Sons Ltd.). British Patent 936,198. Sept. 4, 1963. Filed June 26, 1961.

A prestressed-concrete pressure vessel for nuclear reactors or for storing gas or liquid at high pressure is patented. The vessel is a monolithic concrete cylinder with end slabs. Tensioned cables pass through preformed passages in the concrete and are anchored at both ends by anchorages located at the ends of the pressure vessel. The passages in the cylindrical wall conform to parts of right- and left-hand helices about the axis of the vessel, and at least some of the passages and cables bow out away from the axis. The end slabs contain 2 groups of cables extending at approximately right angles to each other across the axial direction of the cylinder. The cables may be free or grouted-up in the passages in the concrete. (M.P.G.)

40320 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. John Anthony Collis-Smith and Peter John Rawson (to English Electric Co., Ltd.). British Patent 936,205. Sept. 4, 1963. Filed Mar. 17, 1959.

A device for clearing obstacles from the gas-sampling pipes of a graphite-moderated gas-cooled reactor is patented. The gas-sampling pipes extend from the fuel channels to gas-sampling apparatus outside the reactor. The device consists of a head portion, which may be inserted temporarily in the reactor to a location where a duct in the head portion communicates with the appropriate gas-sampling pipe. The duct may be connected to a source of high or low pressure, so that obstacles may be removed from the pipes by applying differential pressure. The device may be part of a charge chute, or a separate device, which can be lowered into the reactor by a grab head and temporarily locked into position. (M.P.G.)

40321 IMPROVEMENTS IN OR RELATING TO MOBILE MACHINES FOR EFFECTING MOVEMENTS OF ELEMENTS THROUGH APERTURES BETWEEN THE INTERIOR AND THE EXTERIOR OF CHAMBERS ADAPTED TO CONTAIN RADIO-ACTIVE MATTER. Richard Henry Evans (to Babcock & Wilcox Ltd.). British Patent 936,451. Sept. 11, 1963. Filed Feb. 6, 1959.

A reactor refueling machine, which may be positioned on the reactor with relative ease, is patented. The machine consists of a shielded container and a mechanism for transferring fuel elements between the container and the reactor tank. A coupling makes a fluid-tight joint around the container opening and any one of a number of tank openings. Two carriages, one mounted on the other and movable in transverse paths, support the container and move it so that the openings in the container and reactor tank are in approximate alignment. The container is pendantly supported by a series of upright tension members, which permit movement of the container relative to the supporting carriages to exact alignment of the openings. (M.P.G.)

40322 IMPROVEMENTS IN AND RELATING TO APPARATUS FOR RAISING AND LOWERING LOADS. Richard Henry Evans (to Babcock & Wilcox Ltd.). British Patent 936,452. Sept. 11, 1963. Filed Feb. 18, 1959.

A brake unit is designed for use with an apparatus to raise and lower loads through a vertical tube by means of a cable. The brake unit prevents uncontrolled falling of the load if the cable breaks. The brake is especially designed for reactor refuelling machines that raise and lower fuel elements into the reactor using a cable. The brake consists of a lower part, which serves as a movable closely fitting piston in the vertical tube, and load-supporting parts, which have brake shoes to force extended braking surfaces against the tube wall when the cable breaks. (M.P.G.)

40323 IMPROVEMENTS IN GRABS. Peter Thomas Hilliard, James Hopper Jenkins, and Kenneth Thomas Peers Langdon (to Babcock & Wilcox Ltd.). British Patent 936,453. Sept. 11, 1963. Filed July 3, 1959.

An automatic grab especially applicable for raising and lowering elements into a reactor core is patented. No power line or auxiliary cable leading to the grab is required. The grab includes jaws on the grab body, which are movable by a rotatable part on the grab body between load-grabbing and load-releasing states. The part is rotated when the grab-moving mechanism is reciprocated through given limits towards and away from the load. (M.P.G.)

40324 IMPROVEMENTS IN NUCLEAR REACTOR REFUELING MACHINES. Kenneth Peers Thomas Langdon, James Hooper Jenkins, and Peter Thomas Hillard (Babcock & Wilcox Ltd.). British Patent 936,454. Sept. 11, 1963. Filed Apr. 14, 1960.

A refuelling machine for operating at the pile cap of a heterogeneous gas-cooled reactor is patented. The machine consists of a pressure vessel containing 2 coaxial rotary magazines, one forming part of the hole preparation

means and the other being the fuel-element container. The pressure vessel is formed with a single bottom opening for the passage of hole-preparation gear and fuel elements. The machine does not need to be moved during refuelling, since the pressure vessel stores fresh fuel elements to be supplied to the reactor, spent fuel elements withdrawn from the reactor, and all the gear required for refuelling. The design and operation of the machine are detailed. (M.P.G.)

40325 IMPROVEMENTS IN ROTARY MOTION TRANSMITTING MEANS EMBODYING CLUTCH MEANS. Peter Thomas Hillard (to Babcock & Wilcox Ltd.). British Patent 936,455. Sept. 11, 1963. Filed Sept. 7, 1960.

A motion-transmitting means for use with a reactor refuelling machine is patented. The mechanism consists of two rotary mounted concentric members, which are separable through relative axial movement. A clutch couples the members together and permits their separation. The clutch includes a movable locking means, which can be withdrawn to release the members from each other or projected to make the clutch effective. The motion-transmitting means may be the drive shaft and gear wheel of a fuel-element charge tube in a refuelling machine. (M.P.G.)

40326 DEVICE PROVIDING A DEFORMABLE FLUID-TIGHT CONNECTION BETWEEN TWO STRUCTURES, IN PARTICULAR BETWEEN TWO NUCLEAR REACTOR ENCLOSURES. Didier Costes and Jean Claude Jacquin (to Commissariat à l'Énergie Atomique). British Patent 936,903. Sept. 18, 1963. Priority date Apr. 10, 1961, France.

A device is patented, which provides fluid-tight access of a movable member to one structure through another structure. The device is particularly designed for the passage of reactor control rods through the biological shield into the reactor tank, making allowance for the displacement of the tank relative to the concrete shield caused by expansion and creep. The control rod slides in and out of the reactor tank through a tubular guide unit. A sealing tube encloses the guide unit and is secured to the reactor tank at one end with the other end projecting through the shield. The sealing tube is deformable to permit relative movements of the tank and shield and has a fluid-tight closure device at its outer end through which an element of the guide unit projects. The angular movements of the guide unit relative to the tank are arranged for universal movement to a limited extent. (M.P.G.)

40327 TEMPORARY FIXING MEANS FOR ELEMENTS CAPABLE OF SLIDING IN THE CHANNELS OF NUCLEAR REACTORS. Didier Costes (to Commissariat à l'Énergie Atomique). British Patent 937,034. Sept. 18, 1963. Priority date Aug. 16, 1960, France.

An apparatus for positioning or withdrawing a cartridge or shell in a reactor channel is patented. The shell is held in position by resilient tongues anchored within the shell, which pass through openings in the shell and engage grooves in the channel wall. The tongues are released by a manipulating rod, which has similar resilent tongues. The tongues on the rod engage grooves in the shell, thereby enabling the shell to be withdrawn from the reactor channel by the manipulating rod. (M.P.G.)

40328 RELEASABLE GRIPPING DEVICE FOR USE IN CHARGING AND DISCHARGING ELEMENTS INTO AND FROM AN INCLINED TUBULAR ELEMENT CHANNEL. (to European Atomic Energy Community (Euratom)). British Patent 937,274. Sept. 18, 1963. Priority date Apr. 14, 1961, Belgium.

The releasable gripping device consists of a rod, which can be inserted into an inclined channel, and having an element-gripping device, a means of raising and lowering the rod from its lower end, and a guiding device for the upper end. A cable passes around a roller at the lower end of the rod and is shortened or lengthened by a winch above the channel, thereby raising and lowering the rod. The gripping means at the lower end of the rod is operated by fluid pressure supplied through a conduit in the rod. The device is designed especially for charging and discharging fuel and sample-bearing elements into heterogeneous reactors. (M.P.G.)

40329 IMPROVEMENTS IN DRIVING MEANS PASSING THROUGH A RADIATION SHIELD. (to European Atomic Energy Community (Euratom)). British Patent 937,337. Sept. 18, 1963. Priority date July 20, 1961, Belgium.

A driving mechanism and shield are designed to prevent radiation escaping where the driving mechanism passes through the shield. The driving mechanism passes through a tunnel in the radiation shield and has one or more driving shafts divided within the tunnel into at least 2 parts with nonaligned axes. The shaft parts are coupled by gears and surrounded by shielding material. The shaft parts and their surrounding shielding material are constructed as readily separable and interchangeable units. The shafts, shielding material, and tunnel are tapered by reducing their cross sections in one or more steps. (M.P.G.)

40330 APPARATUS FOR THE TREATMENT OF GASES. (to Brown, Boveri & Cie., AG). British Patent 937,406. Sept. 18, 1963. Priority date Apr. 25, 1958, Germany.

A device to purify gases, such as those escaping from the circulation system of a nuclear reactor, is patented. The device operates without pumps and can treat efficiently both minute and large quantities of gas. The gases to be treated are fed to an atomizer nozzle in the upper part of a container. The lower part of the container holds a purifying and cooling liquid, which is drawn by the gases into the atomizer nozzel through a stand pipe. The atomized gases pass through a reflux cooler and then to a condenser for further cooling and purification. The purified gas is stored in a gas-collecting bulb or in the outer container of the reactor. (M.P.G.)

40331 NUCLEAR REACTOR FUEL ELEMENT. R. Scott Challender and A. Charles Anthony Saunders (to United Kingdom Atomic Energy Authority). German Patent 1,150,763. June 27, 1963. Priority date May 17, 1960.

The nuclear fuel element described consists of a central body of fissile material contained within a tubular casing. The casing has helical ribs on the outside, the hand of the helical ribs changing several times along the axis. (NPO)

40332 SHUT-OFF MECHANISM FOR NUCLEAR REACTORS. P. Dosch, H. Uhrig, and Hans-Joachim Kraus (to Kernreaktor Bau-und Betriebsgesellschaft, m.b.H.). German Patent 1,151,885. July 25, 1963. Filed Mar. 30, 1962.

The shut-off mechanism described is provided with an accelerating device to speed up the drop of safety rods which are located above the core. The accelerating device imparts a collision momentum to the rods, the collision energy being released in fractions of milliseconds. (NPO)

Power Reactors

40333 (ACNP-6125(Suppl.1)) NUCLEAR SUPERHEAT PROPULSION SYSTEM FOR A PASSENGER LINER. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Nov. 22, 1961. For Gibbs and Cox, Inc., New York. Contract AT(30-1)-2650. 11p. (NYO-9703-07)

A description is given of the reactor, plant, maximum design capabilities, and major full power design parameters. Dose rates during normal operation of the reactor at full power and after the maximum design accident are given. (D.L.C.)

40334 (ACNP-63809(Vol.I)) INLAND ANTARCTIC STATION NUCLEAR POWER PLANT SUMMARY DESIGN REPORT. VOLUME I. DESIGN DATA. (Allis-Chalmers Mfg. Co., Milwaukee). July 1963. Contract AT(30-1)-3111. 180p. (NYO-10516(Vol.I))

For Drawings see CAPE-1051.

The design, costs, and logistics of the Inland Antarctic Station Nuclear Power Plant are presented. The design establishes that a 1.3 Mw gross electric plant can be built, installed, and operated safely in a snow tunnel in Antarctica. The plant is designed for 20 yr life and will cost $8,776,403. The design of the plant is based on redesign of the PM-3B plant to reduce its weight, size, and complexity. (N.W.R.)

40335 (ACNP-63809(Vol.II)) INLAND ANTARCTIC STATION NUCLEAR POWER PLANT SUMMARY DESIGN REPORT. VOLUME II. PRELIMINARY SAFETY ANALYSIS. F. T. Matthews, comp. (Allis-Chalmers Mfg. Co., Milwaukee). July 1963. Contract AT(30-1)-3111. 310p. (NYO-10516(Vol.II))

For Drawings see CAPE-1051.

The hazards of the various credible accidents possible for the Inland Antarctic Station Nuclear Power Plant are reviewed and the plant is described. A maximum credible accident is postulated and its hazards are studied. The analysis indicates that there are no hazards to personnel either during normal operating conditions or in the event of the maximum credible accident. (N.W.R.)

40336 (CEND-164) CRITICAL EXPERIMENTS FOR PL-2 AND THEIR ANALYSIS. O. Gallar, R. S. Harding, and R. W. Knapp (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). Aug. 1962. Contract AT(11-1)-1062. 140p.

The critical experiments showed that the original specification of 1.0 wt % for the boron concentration could be reduced to 0.25 wt % without reducing the one-rod-out shutdown margin below 2½% reactivity as measured by rod drop experiments. Good agreement was obtained between calculated and measured eigenvalues for the small, clean cores which were analyzed. In cores with no control rods and containing all fuel, 0.0, 0.25, or 1.1 wt % boron-stainless steel, and with all 0.25 wt % boron-stainless steel and fuel elements surrounded by aluminum-water displacers, the calculated eigenvalues were 0.7 to 1.0% greater than the measured values. In a core with 0.25 wt % boron-stainless steel and with the center control rod fully inserted, the calculated eigenvalue was 1.0% larger than measured. In one case, a core composed entirely of fuel and with the center control rod fully inserted, the calculated eigenvalue was 0.33% Δk smaller than that measured. The calculated power distributions compared extremely well with those measured in the fuel assemblies. Shutdown measured by the boron substitution method, where the worth of the boron was measured by calibrating both a single control rod and a bank of rods, was found to give consistent results which in turn agreed to within 0.5% Δk with shutdown measured by the rod drop technique. The rod drop measurements with 0.25 wt % boron gave a shutdown of 2.52% with the central control rod withdrawn. Correcting for the small difference between the mockup and the reference core, the shutdown margin for the PL-2 was 3% Δ k/k. Shutdown measurements obtained by moving a calibrated control rod from all into its critical position and maintaining criticality by the compensating motion of another rod or rods, were found to give widely differing results depending on the combination of rods used. Measurements in a boron-stainless steel zoned core where the boron-stainless steel poison rods were removed from the outer 12 peripheral subassemblies and replaced with fuel elements, show that the center rod remains the strongest, that the center-rod-stuck-out shutdown margin is reduced very little (–0.28% Δk) from the core containing boron-stainless steel in all subassemblies, and that 1.09% reactivity is gained at beginning of life by removing this boron-stainless steel. (auth)

40337 (CVNA-189) MONTHLY OPERATING REPORT [ON CVTR OPERATION], JULY 1963. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). Contract AT(30-1)-2289. 33p.

Operation of the reactor was confined in the first half of the month to completion of the basic physics tests. The discovery of the excessive leakage of sweep gas from the header cavity halted continuation of any further testing with the major emphasis being placed on the location and sealing of these leaks. A considerable amount of work was done in the checking and revising various fuel handling tools, building racks for containing these tools, and other fuel handling equipment. Further testing verified the presence of a large percentage of damaged tubes in the component cooling water heat exchangers, requiring that these exchangers be sent back to the vendor for reworking. Water chemistry throughout the plant fell generally well within operating limits with no further degradation of either the Primary System or Moderator D_2O. (auth)

40338 (GEAP-3967(Rev.)) HIGH POWER DENSITY DEVELOPMENT PROJECT INTERIM REPORT. 300 MWe HPD CONCEPTUAL DESIGN STUDY. V. G. Grayhek and A. P. Bray (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). June 1962. Contract AT(04-3)-361. 35p.

The analysis of reactor core power density and moderator void distribution was conducted. This analysis consisted of the development of a set of seven reactor core thermal hydraulic designs to prescribed power densities and moderator void fractions. This entire development will be employed in the overall conceptual design study in which reactor design economics are to be considered. (auth)

40339 (GEAP-4217) DEVELOPMENT OF PULSED NEUTRON APPLICATION TO POWER REACTOR START-UP PROCEDURES. Quarterly Progress Report No. 4, January 1–March 31, 1963. Edward Garelis and Paul Meyer (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). May 13, 1963. Contract AT(04-3)-189. 15p.

A 3 wt % UO_2 stainless-clad core containing boric acids in various concentration was pulsed to determine the validity of the $k\beta/l$ technique. Non-uniformity of the source strength, however, made the $k\beta/l$ theory inapplicable. The experiments did show that the effect of the pulse rate on the determination of $k\beta/l$ is very pronounced and that a

sharp leveling off occurs at a pulse rate of 10/sec. Pulse work on a 64-element Humboldt Bay core gave a neutron density vs time curve with several peaks rather than one. No multiple peaks were observed when the 172-element, fully-loaded core was pulsed with a higher yield source. Pulsing experiments were also carried out on some storage configurations in the spent-fuel pool with a $k_e \approx 0.65$. The design and performance of the apparatus used in these experiments is also reported. (D.C.W.)

40340 (GEAP-4309) HIGH POWER DENSITY DEVELOPMENT PROJECT THIRTEENTH QUARTERLY PROGRESS REPORT, APRIL–JUNE 1963. R. L. Holladay, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 1, 1963. Contract AT(04-3)-361. 81p.

The number of Task 1A fuel bundles under irradiation in the VBWR core was reduced from 24 to 9 as a result of fuel rod service failures. Fuel bundles (2E, 3E, 4E, 5E, 6E, 2F, and 4G) were classified as failures. The average burnup of the Task 1A operating fuel assemblies in the core was 6301 Mwd/t through June 2, 1963. Several special assemblies failed, including 3S, 5S, 6S, and 7S. Assemblies 8S and 10S were removed from the reactor as suspect leakers. The average assembly burnup of the Task 1B assemblies is 3746 Mwd/t, excluding the failed assemblies. Fuel assembly 12S is being fabricated using selected free-standing, 0.014-mil wall annealed rods retrieved from the E series assemblies. Fuel assembly 1SM will be modified to include 13 vibratory compacted rods from 7S. Four instrumented assemblies were transferred to Big Rock Point after successful proof testing in the heat transfer loop under hot single-phase and two-phase conditions. Upon reaching power, the flowmeters started showing signs of failure, and after 3 days at power all meters had failed. The flowmeter failures were caused by an accumulation of grit on the bearing surfaces. Preliminary data were taken at Big Rock Point both in the areas of stability and core performance; and some observations based on these data were made. The effect of reloading patterns on gross power peaking was studied in three dimensions. A quantitative comparison of four patterns with regard to peaking factor and reactivity requirements was obtained. Calculations were performed to estimate the discharge exposure of each fuel element which will be used in the Big Rock reactor. Reactivity comparisons were carried out at Big Rock to verify that the four instrumented assemblies agree with expectations, and power distribution and control rod worth calculations were performed in support of the planned rod oscillator tests. The final writing, assembly, and checkout of the on-line computer programs at Big Rock Point were accomplished. After checkout, the entire system was put on line and operated quite well, with much data being generated. (auth)

40341 (GNEC-141(Del.)) GAS-COOLED REACTOR PROJECT PROGRESS REPORT NO. 7. (General Nuclear Engineering Corp., Dunedin, Fla.). Sept. 15, 1960. For East Central Nuclear Group and Florida West Coast Nuclear Group, Inc., St. Petersburg, Fla. Contract [AT (38-1)-200]. 229p.

The status of the design and development program for the ECNG-FWCNG prototype gas-cooled heavy-water-moderated pressure-tube-type reactor is reviewed, and work done during the period March 1 to August 31, 1960, is reported. It was decided to develop beryllium-clad fuel elements for the reactor, and the fuel pellet design was changed to an annular shape with the central core filled with BeO. Corrosion testing of Zr alloys is continuing. (D.L.C.)

40342 (LAMS-2973) QUARTERLY STATUS REPORT ON LAMPRE PROGRAM FOR PERIOD ENDING AUGUST 20, 1963. (Los Alamos Scientific Lab., N. Mex.). Sept. 1963. Contract W-7405-eng-36. 17p.

Experiments and operations in LAMPRE are reviewed. Fabrication, properties, and radiation testing of LAMPRE fuel elements are studied. The development of Pu–Co–Ce fuels is discussed. Phase studies on Ce–Co, Ce–Ni, Ce–Mn, Pu–La, and Pu–Pr systems are reported. Ta corrosion by Na is examined. The progress in construction of a Core Test Facility is outlined. (T.F.H.)

40343 (NAA-SR-8431) A MATHEMATICAL MODEL DESCRIBING THE DYNAMICS OF THE SRE CORE II. R. W. Keaten, A. L. Gunby, and W. J. Carlson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 15, 1963 Contract AT-11-1-GEN-8. 32p.

A mathematical model explaining the dynamics of the Sodium Reactor Experiment (SRE) Core II, prior to constraint of the fuel clusters, is presented and is shown to match the measured SRE behavior. The model uses an axial space-independent, nodal approach, postulating separate coolant flow regions inside and outside the fuel cluster, plus a "mixing flow" between them. The model reproduces the power coefficient and flux oscillations by demonstrating the effect of the mixing flow on fuel-rod bowing. (auth)

40344 (NP-13123) O.E.C.D. HIGH TEMPERATURE REACTOR PROJECT DRAGON. FOURTH ANNUAL REPORT, APRIL 1, 1962–MARCH 31, 1963. (European Nuclear Energy Agency, Paris). 160p.

A survey is presented of the work carried out from April 1, 1962 to March 31, 1963. Design work and civil construction were virtually completed in this period, and the dummy core was installed. The survey is divided into sections entitled research and development, reactor design and construction, assessment work, and administration. (D.L.C.)

40345 (TID-19458) HEAT TRANSFER AND HYDRAULIC STUDIES FOR SNAP-4 FUEL ELEMENT GEOMETRIES. Topical Report No. 1. Bruce Matzner and Ralph Biderman (Columbia Univ., New York. Engineering Research Labs.). Aug. 1963. Contract AT(30-3)-187. 13p.

Burnout, pressure drop, and heat transfer data are given for a closely spaced, wire wrapped 12-rod test section cooled by boiling water in vertical upflow at 1200 psia. The bundle consisted of (12) 0.440 in. OD rods, 17 in. long wrapped on a 6 in. pitch with 0.022 OD hypodermic needle tubing. The rods were arranged in 3 rows of 4 rods each forming a 60° parallelogram with a minimum spacing of 0.022 in. between adjacent rods and between the outer rods and the shroud walls. The ranges of variables studied were: mass velocities between 0.85 and 4.1×10^6 lb/hr-ft^2, exit qualities between 8 and 21% and instrumented burnout heat fluxes as high as 0.955×10^6 Btu/hr-ft^2. (auth)

40346 (WAPD-PWR-TE-149) EVALUATION OF DLCS3890202, STEAM GENERATOR BLOWDOWN RATE (INTERNAL INSPECTION). W. R. Greenaway (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Feb. 1963. Contract [AT(11-1)-Gen-14]. 9p.

Periodic internal inspections of the PWR steam generators were made to study the effectiveness of sludge removal at increased blowdown rates. The blowdown rate was increased from 5500 to 25000 lb/hr in Aug. 1961, and

the last inspection was made on Nov. 29, 1962. The sludge samples were analyzed and the 1961 and 1962 analyses are compared. It is concluded that the sludge accumulation is about the same, and that a blowdown rate of 25000 lb/hr at 2-week intervals does not prevent the accumulation. (D.L.C.)

40347 (WAPD-PWR-TE-153) CONTROL ROD DRIVE MECHANISM TESTING DURING SEED 3 OPERATION AND SEED 3-4 REFUELING. P. W. Secrist (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Apr. 5, 1963. Contract AT-11-1-GEN-14. 6p.

The test data reported for the periodic testing during Seed 3 and for the precritical and initial critical testing after the third refueling indicate that the mechanisms operated satisfactorily during Seed 3, have sufficient wear life remaining for Seed 4 operation, and were operating satisfactorily as installed at the completion of the third refueling period. Several deficiencies were found and corrected during the precritical checkout which proves the test necessary. The satisfactory results of the precritical and initial critical test assured that the mechanisms were operating satisfactorily as installed. Although no deficiencies were discovered during the periodic testing, the accumulated wear data and determination of mechanism performance characteristics confirmed that the mechanisms were operating satisfactorily and adequately during Seed 3 and that sufficient wear life remains for Seed 4 operation. (auth)

40348 (WAPD-TM-390) SHIPPINGPORT ATOMIC POWER STATION OPERATING EXPERIENCE, DEVELOPMENTS, AND FUTURE PLANS. J. T. Stiefel (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh), H. Feinroth (Division of Reactor Development, AEC), and G. M. Oldham (Duquesne Light Co., Shippingport, Penna.). Apr. 1963. Contract AT(11-1)-Gen-14. 67p.

A description and evaluation are given of the experience obtained during five years of operation and testing of the Shippingport station. The core and plant performance is also described. A discussion is given of some of the more important current technical developments and future plans. (D.L.C.)

40349 (WCAP-2255) SURVEY OF SODIUM PUMP TECHNOLOGY. D. R. Nixon (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). June 1963. Contract AT(30-1)-3123. 67p.

A review is presented of the current status of sodium pump development as related to nuclear power applications. A description is given of the design features and performance characteristics of the more important types of sodium and sodium–potassium alloy (NaK) pumps. Some requirements for sodium pumps for future large liquid metal reactor systems are presented with some preliminary consideration of the potential of various pump types to meet these requirements. (auth)

40350 (JPRS-21241) THERMODYNAMIC CYCLES OF ATOMIC POWER STATIONS WITH AN MHD GENERATOR. D. D. Kalafati. Translated from p.251-4 of "Thermodinamicheskie Tsikly Atomnykh Elektrostantsii" (A publication of the State Power Publishing House, Moscow-Leningrad, 1963). 4p. (OTS-63-31837)

The principle of the MHD generator is discussed briefly. Graphs of thermodynamic cycles are given for a nuclear power plant with a MHD generator alone, with a MHD generator in combination with a gas turbine, and with a MHD generator in combination with a steam turbine. It is concluded that high thermal efficiencies are probable for MHD generators in the future. (D.L.C.)

40351 CALCULATING THE REGENERATIVE PREHEATING TEMPERATURE OF WATER IN A NUCLEAR POWER PLANT WITH DOUBLE CIRCULATION. D. Grekov. At. Energ. (USSR), 15: 76-7(July 1963). (In Russian)

It is assumed that the reactor power is constant in determining the final optimum temperature t_a^{opt} of the preheat water. Two cases can be distinguished: (1) the vapor pressure in the first cycle is constant, and a change in t_a results in a temperature change of the inlet water to the reactor; (2) the inlet water temperature t_1 and the exit water temperature t_2 from the reactor do not change, and a change in t_a leads to a change of vapor pressure in the active core of the reactor. The factors having an effect on the net efficiency of a power plant can be expressed as follows: $\eta_i = [\eta_t \eta_{oi} - B/(c_p^3(t_2 - t_1)^3 \gamma_a \gamma_1)]\eta_{ga}$. Here η_t is the thermodynamic efficiency of the nuclear unit, η_{oi} is the relative internal efficiency of the turbine, c_p is the specific heat capacity of the water in kcal/kg-°C, γ_a is the average density of the water in the active reactor zone, γ_1 is the density of the water at the pump (compressor) inlet, and η_{ga} is the efficiency of the vapor generator. B depends on the geometry of the core, the fuel elements and type of heat transfer medium. A value of t_a^{opt} is derived from the condition that $\partial\eta_i/\partial t_a = 0$. An increase in t_a causes a decrease in the vapor pressure, and the increase in efficiency due to the higher preheat temperature t_a is offset by the decrease in vapor pressure p_o. (TTT)

40352 THE ROLE OF PLUTONIUM IN THE BRITISH NUCLEAR POWER PROGRAMME. H. Kronberger. Atom, No. 82, 240-50(Aug. 1963).

There are two principal incentives for the utilization of plutonium in reactors as part of the British Nuclear Power Programme. Plutonium will become available in increasing amounts from the natural uranium reactors, and assessments indicate that fast reactors burning plutonium may produce power more cheaply than any other reactor systems so far envisaged. The nuclear characteristics of plutonium were examined both for thermal and fast reactors, and it was shown that plutonium burning is feasible in both, but can be used more efficiently in fast fission systems. Economic assessments were made of the value of plutonium to individual reactor systems. These indicate a range of £2 to £4-5 a gram for plutonium in thermal reactors and an upper limit of £6 a gram in fast reactors. However, another and probably more logical approach is to consider plutonium as an intermediate product in an integrated system of plutonium producing and plutonium burning reactors, in which case there is no need to assign a value to plutonium the aim being to devise an optimum combination of reactors to provide a minimum over-all generating cost. A minimum buying or selling price can, however, be calculated by this approach. It is believed that plutonium will play a vital role in achieving the aim of really cheap nuclear power. (auth)

40353 A GENERAL METHOD FOR CALCULATING REACTIVITY AND DISCHARGED FUEL IRRADIATION IN FUEL CYCLES. M. Paoletti Gualandi, F. Vicentini Orgnani, and S. Felici (AGIP Nucleare, Milan). Energia Nucl. (Milan), 10: 423-30(Aug. 1963). (In English)

Fuel cycles for industrial Calder Hall type reactors are examined. A general method to study the reactivity variations and the mean discharged fuel irradiation variations during the reactor life is given. The results of an application of the method to a particular type of fuel cycle are shown. (auth)

40354 ECONOMICAL NUCLEAR POWER: A CANADIAN POINT OF VIEW. F. H. Krenz (Atomic Energy Canada Ltd., Chalk River, Ont.). Energia Nucl. (Milan), 10: 435-41(Aug. 1963). (In Italian)

The Canadian concept of heavy water–natural uranium power reactor has entered the ranks of the proven types of reactors with the successful operation of NPD and the construction of CANDU. A brief survey of electrical power costs show that, under the present system of financing in Italy, the Canadian nuclear power station is clearly competitive with coal-fired stations in the Italian economy. The advantages of the Canadian system lie in the extremely simple fuel cycle employing low-cost, natural uranium oxide fuel. Other features of the system are briefly described. Current development shows that there is considerable potential for an organic liquid cooled reactor of the heavy water–natural uranium type. (auth)

40355 THE G-1 REACTOR. D. Martin. Energie Nucl., 5: 221-5(June 1963). (In French)

The G-1 reactor, fueled with natural U, cooled by gas under pressure, and moderated with graphite, was the first industrial project of the CEA and went critical January 7, 1956. The core, cooling, control and operation, and fuel loading and unloading are described. The behavior of these elements and the auxiliary plants are described. Evidences of the Wigner effect and the precautions taken against it have been studied in some detail. (J.S.R.)

40356 THE G-2 AND G-3 INDUSTRIAL COMPLEXES. L. Maillard. Energie Nucl., 5: 226-30(June 1963). (In French)

The G-2 and G-3 installations, unlike the G-1 that is of a simplified design, were constructed around plutonium production reactors for the production of electricity. The horizontal arrangement of the channels to facilitate uniform irradiation of the fuel rods, the use of a pre-stressed concrete reactor vessel, and fuel loading and unloading without shutdown were radial innovations. These design factors, the cooling circuits, and the thermal and neutron characteristics of the reactors are briefly described to illustrate the motives for the selection of these characteristics. (J.S.R.)

40357 FUEL HANDLING IN THE G-2 AND G-3 REACTORS. P. David, G. Derome, and A. Ertaud. Energie Nucl., 5: 231-7(June 1963). (In French)

The fuel handling system of the G-2 and G-3 reactors that allows the reactor to be loaded and unloaded without shutdown is described. The regulation and control of this operation is completely automatic. The new fuel rods, as they are pushed in at one end, push the old fuel rods out the other end of the channel. These spent rods are crated and sent to the deactivation pool. The heavy loading machines are positioned with a precision of one mm in order to obtain tight coupling at each end of the channel. There were difficult development problems to be solved because of the numerous directional changes of the rods. (J.S.R.)

40358 CONSTRUCTION OF THE G-2 AND G-3 REACTORS. Guy Richard. Energie Nucl., 5: 238-44(June 1963). (In French)

The construction of the G-2 and G-3 Reactors was characterized by its rapidity, which was possible because design studies and construction were conducted in parallel. The construction phases are described by indicating the original design concepts. The building of the complex raft ironwork, construction of a prestressed concrete vessel with subsequent hydraulic testing, setting up of the interior of the reactor vessel, and mounting of the electromechanical equipment are the phases discussed. (J.S.R.)

40359 THE G-2 AND G-3 REACTORS. RECORD OF FOUR YEARS OF OPERATION. F. Conte. Energie Nucl., 5: 245-9(June 1963). (In French)

In the course of the power-increase stages of the G2 and G3 reactors, some interesting information was accumulated on the new techniques adopted. These have been justified in the increased performance obtained, thanks especially to the choice of prestressed concrete for the vessel, to the loading-unloading without reactor shutdown, to the high automation of the vessel control, and to the independence of the blowing systems of the cooling gas. (auth)

40360 THE MARCOULE POWER PLANT. EXPERIENCE, RESULTS, AND INFORMATION GAINED IN THE FIELD OF PRODUCTION OF ELECTRICITY. J. Kieffer. Energie Nucl., 5: 250-6(June 1963). (In French)

The construction and operation of the G-1, G-2, and G-3 power plants in connection with energy recovery plants have given Electricité de France the opportunity to gain experience with the problems that the introduction of nuclear energy into the national electric complex present. The solutions adopted for G-1 differ from those adopted for G-2 and G-3 because of the greater complexity and higher unit power of the latter reactors. The engineering and economic information gained–particularly the flexibility of the recovery installation in adapting to different types of reactor operation–is briefly indicated. (J.S.R.)

40361 THERMODYNAMIC STUDIES OF SINGLE-CIRCUIT NUCLEAR POWER PLANTS WITH ORGANIC-COOLED REACTORS. W. Fratzscher and P. Koenig (Technische Universität, Dresden). Kernenergie, 6: 381-9(Aug. 1963). (In German)

With the help of circuit-process characteristics, the most important circuit processes with organic operating media were investigated. These processes can be important in nuclear engineering for a direct supply of the coolant from the reactor to the turbine. Results of the investigation showed, both qualitatively and quantitatively, a close relationship to the water-vapor and gas turbine processes whereby the most important thermodynamic quantities, thermal efficiency, and circuit-process work of the organic process lie between the two kinds of processes. (tr-auth)

40362 PEACH BOTTOM: THE ULTIMATE IN REACTORS. Titus G. LeClair and Donald Hunter. Mod. Power Eng., 56: 97-100; 105-(Oct. 1962).

The Peach Bottom high-temperature gas-cooled reactor program is discussed. The key to the goal of economic nuclear power lies in high-temperature operation for the direct production of steam at high-efficiency steam-turbine conditions. It is because of this that Peach Bottom promises a total cost of about 2.5 mills/kwh. The Peach Bottom plant design is discussed. (R.E.U.)

40363 EL4—AN ADVANCED NATURAL URANIUM REACTOR. Nucl. Eng., 8: 312-16(Sept. 1963).

The EL4 power station, being built in the Arrée Mountains in Brittany, is a prototype power reactor moderated with heavy water and cooled by forced circulation of CO_2. Natural or slightly enriched uranium oxide used as fuel achieves a high burn-up in the region of 10000 Mwd/t with reprocessing being necessary. Main parameters of the EL4 and a schematic drawing are given. (R.E.U.)

40364 RAPSODIE—A VITAL FAST REACTOR PROJECT. R. Wustner. Nucl. Eng., 8: 316-21(Sept. 1963).

Rapsodie is to be a sodium-cooled, experimental fast reactor with an all-plutonium core. It is designed to have a thermal power output of 20 Mw. The design of Rapsodie was such as to provide industrial experience that could be used directly in the design of a prototype power reactor. The first core of Rapsodie is to be a ceramic mixture of oxides UO_2-PuO_2. A description and schematics of the reactor are given. (R.E.U.)

40365 TEST RIGS FOR THE RAPSODIE COOLANT CIRCUITS. L. Vautrey. Nucl. Eng., 8: 321-3(Sept. 1963).

The sodium coolant circuits of the Cadarache Reactor (Rapsodie) are described. Modifications of the original design for purification circuits, pre-heating system, mechanical pumps, and terminal exchanger are given. (R.E.U.)

40366 EDF 1 AND 2 PRESSURE VESSEL DESIGN AND CONSTRUCTION. Georges Lamiral. Nucl. Eng., 8: 326-9(Sept. 1963).

Some of the design problems encountered in the course of fabrication of the pressure vessels for the EDF1 and EDF2 reactors at Chinon are presented. Magnesium–molybdenum steel was used in fabrication, and special exemption from French regulations relating to pressure vessels had to be obtained. (R.E.U.)

40367 THE CLOSED CYCLE WATER REACTOR—PAST, PRESENT AND FUTURE. F. S. Bloxam and J. N. Kilpatrick (Westinghouse Electric Corp., Pittsburgh). Nucl. Eng., 8: 359-64(Oct. 1963).

The operation performance of six power plants of the Closed Cycle Water Reactor (CCWR) type is reviewed briefly: Shippingport, Yankee, BR-3, SELNI, SENA, and Saxton. The design concepts involved in the design of projected CCWR plants are discussed. New CCWR plants being planned are Camp Pendleton, Los Angeles (Malibu), Connecticut Yankee, and Ravenswood "A". The Development potential and economic aspects of CCWR technology are discussed. (D.L.C.)

40368 NUCLEAR POWER IN CZECHOSLOVAKIA. A. D. Wordsworth. Nucl. News, 6: No. 10, 7-10(Oct. 1963).

The organization of nuclear activities in Czechoslovakia is surveyed, and the nuclear power program is described. A description is given of the 150-Mw(e) KS-150 D_2O-moderated gas-cooled power reactor at Bohunice. The fuel elements, pressure vessel, and construction of this reactor are discussed. Other nuclear research activities in Czechoslovakia are described briefly. (D.L.C.)

40369 NUCLEAR POWER STATION WITH D_2O-MODERATED PRESSURE TUBE REACTOR FOR HIGH TEMPERATURES. Wolfgang Keller and Hans-Joachim Preuss. Siemens-Z., 37: 302-4(Apr. 1963). (In German)

The design and construction of the D_2O-moderated pressure tube reactor being constructed by Siemens-Schuckertwerken is described. The reactor will have a net electrical output of 100 Mw. It is cooled with CO_2, and UO_2 is the fuel. A cross section of the reactor is given. The thermal cycle, control and shut-down system, fuel element transport device, and the reactor double containment are discussed. (J.S.R.)

40370 PROJECT FOR A TANKER WITH ATOMIC PROPULSION. Wolfgang Braun and Karl-Heinz Otte. Siemens-Z., 37: 305-7(Apr. 1963). (In German)

A brief summary is given of the results of a study on a nuclear-propelled tanker. A pressurized water reactor was selected as the propulsion unit. The location of the reactor on the ship and the reasons for this location are discussed. The special factors that must be taken into consideration in the design of such a tanker are indicated. The safety requirements for a nuclear tanker are considered. (J.S.R.)

40371 GAS COOLED REACTORS FOR THE "SECOND GENERATION" POWER PLANTS. Giuseppe Zamparo (A.C.F. Industries, Inc., Washington, D. C.). Termotecnica (Milan), 17: 335-38(1963). (In Italian)

A brief review is made of the characteristics of second generation gas-cooled reactors with emphasis on the Gas Cooled Power Reactor designed by the American Car and Foundry Industries in collaboration with Kaiser Industries. The fuel is enriched in one design to the percent necessary to maintain a reactivity adequate to a mean life of 10,000 Mwh/ton. The properties of the reactor with natural U are also considered. (J.S.R.)

40372 NUCLEAR POWER STATION WITH PRESSURE-TUBE REACTOR FOR HIGH TEMPERATURES. Herbert Juettemann. VDI (Ver. Deut. Ing.) Z., 105: 1268(1963). (In German)

A 100-Mw nuclear power station with a D_2O-moderated pressure-tube reactor was designed for the "Atomkraft Bayern." Instead of the usual reactor pressure vessel used with nuclear power stations this reactor is equipped with pressure tubes. The steam at the outlet of the steam generator is about 500°C and 1500 psi. More useful effects can be obtained as compared with those of the conventional saturated steam turbines in use with nuclear power stations. (auth)

40373 SPECIFICATIONS FOR THE ELPHR (Engineering Materials). (Chicago Operations Office, AEC). (CAPE-994)

Specifications on 51 systems and components of the Experimental Low-Temperature Process Heat Reactor are given. (P.C.H.)

40374 IL CICLO COMBUSTIBILE U–Th. VI CONGRESSO NUCLEARE DI ROMA 13-15 GIUGNO 1961. (The U–Th Fuel Cycle. Sixth Nuclear Congress at Rome, June 13-15, 1961). Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. 607p. Prezzo Lire 3500.

Twenty-seven papers are included; separate abstracts have been prepared for 22. Five papers were previously abstracted in NSA. Twenty-four of the papers are in English, 1 in French, and 2 in Italian. (T.F.H.)

40375 THORIUM AS A NUCLEAR FUEL. U. M. Staebler. p.3-15 of "Il Ciclo Combustibile U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

An outline is given of the feasibility of $Th^{232}-U^{233}$ breeder power reactors. Attention is given to the physical, reactor-physics, fuel materials and processing, and programmatic aspects of this type of reactor. (T.F.H.)

40376 NUCLEAR FUEL CYCLES AND THE P.C.U.T. PROGRAM. A. Forcella and J. K. Davidson. p.17-27 of "Il Ciclo Combustibile U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

The economics of Th and U^{238} breeders are compared, as functions of reactor power and operating parameters. The Th-cycle costs are determined for the cases in which the fuel is reprocessed internally or returned to the supplier. (T.F.H.)

40377 AN ECONOMIC COMPARISON BETWEEN THE Th–U-235 AND THE U-238–U-235 FUEL CYCLES FOR VARIOUS REACTOR TYPES. R. T. Shanstrom. p.59-79

of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

The economics of breeder reactors using Th^{232} or U^{238} as fertile material are compared, with respect to their uses in four types of thermal power reactors: PWR with stainless steel cladding; PWR with Zircaloy-2 cladding; BeO-moderated, He-cooled; and graphite-moderated and -clad, He-cooled. U^{235} is used as fuel in both Th and U breeders. Batchwise and continuous methods of fuel management are also compared. (T.F.H.)

40378 THE THORIUM FUEL CYCLE IN SPECTRAL SHIFT CONTROLLED REACTORS. M. C. Edlund. p.125-41 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

The basis for spectral-shift control of a reactor (viz., varying the D_2O–H_2O concentrations) is outlined. The improvements in power economy that spectral-shift control offers in Th-breeding pressurized water reactors are evaluated. (T.F.H.)

40379 FUEL CYCLE ANALYSIS OF A Th–U^{235} REACTOR. E. A. Mason and J. M. Neill. p.143-62 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

A computer code (WATTHO) is described for fuel cycle analyses in multiregion Th^{232} breeder reactors utilizing U fuel. An application to a three-radial-zone PWR is shown. WATTHO is written for the IBM-709 computer. The physical model for WATTHO is two-dimensional, two-group, four-region diffusion theory in an axisymmetric cylindrical geometry. (T.F.H.)

40380 THE INFLUENCES OF THORIUM ON THE DESIGN OF THE CONSOLIDATED EDISON THORIUM REACTOR. H. S. Barringer and J. C. Deddens. p.165-73 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

The core operating lifetime and characteristics, control rod worths, reactivity control distributions, power density distributions, control systems, and other design aspects of the Indian Point Power Reactor are discussed. The effects of Th on these design features and on fuel costs are studied. (T.F.H.)

40381 THE DRAGON REACTOR. G. Franco. p.175-99 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In Italian)

A description of the Dragon High-Temperature Gas-Cooled Reactor Experiment is given, along with characteristics and design features. Experimental problems and their solutions are discussed. The cooling system is described. Removal of contaminated components, as well as fuel handling methods, is outlined. (T.F.H.)

40382 FEATURES AND AIMS OF THE HIGH-TEMPERATURE GRAPHITE-MODERATED REACTOR SYSTEM. P. Fortescue. p.201-13 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

The design characteristics of the Peach Bottom Power Reactor are outlined. The advantages of this class of reactor (high temperature; gas-coolant; dispersion U–Th fuel; graphite moderator, fuel-canning, and fuel-matrix) are enumerated. (T.F.H.)

40383 ADVANCED EPITHERMAL THORIUM REACTOR (A.E.T.R.) CRITICAL EXPERIMENTS, REACTOR DESIGN AND FUEL ANALYSIS. D. T. Eggen. p.215-43 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (AI-6445). (In English)

The development of the A.E.T.R. concept that comprises sodium cooling, epithermal-to-fast operation, Th breeding, and other features that can be varied is described. Particular attention is given to critical experiments, reactor design, and fuel element and fuel cycle analyses. (T.F.H.)

40384 MOLTEN-SALT REACTOR SYSTEMS. R. B. Briggs. p.245-71 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

The feasibility of one-region and two-region molten-salt-fueled breeder reactors is discussed. Economics of a power station using such a reactor is studied. The Molten Salt Reactor Experiment is described. The phase properties of $LiF–BeF_2–(ThF_4–UF_4)$ solutions are shown. The properties of INOR-8 alloy for use in molten-salt reactors are reviewed. (T.F.H.)

40385 THE ELK RIVER REACTOR. J. J. Dickson and J. H. Blachly. p.273-302 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

The design, economic, engineering, plant layout, and procedural aspects of the Elk River Power Reactor are reviewed. The reactor is boiling-water cooled, urania–thoria-fueled, and uses a coal-fired superheater. (T.F.H.)

40386 THE P.C.U.T. FACILITY FOR REPROCESSING AND REFABRICATING $ThO_2–UO_2$ FUELS. J. K. Davidson, O. Drolshagen, O. Nepi, G. Orsenigo, and A. C. Schafer. p.305-17 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

A pilot-plant facility for processing and reconstituting fuel elements for reactors based on the Th–U^{233} cycle is described. Scale-up of the plant to full size is discussed. The pilot plant is Italian and is part of the Uranium–Thorium Fuel Cycle Program (P.C.U.T.). (T.F.H.)

40387 PURIFICATION OF URANIUM-233 BY EXTRACTION WITH TRILAURYLAMINE SULFATE. A. Chesne and F. Mannone. p.319-39 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In French)

A method is described for purifying the U^{233} obtained by the separation of U^{233}–Th breeder fuels. The U and Th are separated by cation exchange followed by anion exchange. The U^{233} from this separation contains small amounts of Th, fission products, Pa^{233}, and corrosion products. These small amounts of impurities are then removed by multistage liquid-liquid solvent extraction using trilaurylamine sulfate. (T.F.H.)

40388 EXPERIMENTS IN PYROMETALLURGICAL PROCESSING OF THORIUM–URANIUM FUELS. E. W. Murbach and G. E. Brand. p.341-55 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

Methods for reprocessing core and blanket fuels of Th breeder reactors are reviewed, including volatilization, arc melting, induction drip melting, salt-bed refining, molten-salt electrolysis, and magnesium extraction techniques. (T.F.H.)

40389 PROBLEMS RELATED TO TREATMENT OF THORIUM AND URANIUM NITRIC SOLUTIONS. S. Sartori, G. Celino, and G. R. Guidotti. p.357-80 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

Parameters for dissolution, feed adjustment, and head- and tail-end treatment are studied in order to improve the chemical flowsheet of a thoria-urania fuel reprocessing plant. (T.F.H.)

40390 CHEMICAL REPROCESSING IN C.N.E.N.'s P.C.U.T. PILOT PLANT. A. C. Schafer, G. Orsenigo, and F. Fumagalli. p.381-402 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

A remote-operated processing facility is described that can process 15 kg/day of ThO_2–UO_2 fuel having an enrichment in U^{233} of 10% or less. A single solvent extraction cycle is included to reduce the fission-product activity to the same order as the steady-state U^{232} and Th^{228} activity. No attempt is made to remove all fission-product activity because the U^{232} and Th^{228} activities, which cannot be removed by chemical processing, themselves preclude the direct processing of the fuel. The fuel is allowed to cool 90 to 120 days between removal from the reactor and processing. After the solvent extraction of the dissolved fuel, the Th/U ratio is adjusted in the decontaminated solution by means of a makeup solution, and the resulting solution is processed into a mixed ThO_2–UO_2 powder. (T.F.H.)

40391 AN ALTERNATE POSSIBILITY FOR THE U–Th CYCLE. M. Grenon. p.471-6 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

The feasibility of a fluidized-fuel Th breeder reactor using fuel particles having dimensions of about 4 to 6 microns is discussed. The fuel-particle size is chosen to allow fission products to be ejected from the fuel into the fluidizing medium. A second material is incorporated in the fluid, with the purpose of adsorbing the fission products. The adsorbent material is easily separated from the fuel by hydromechanical means in a permanent bypass loop. Thus there is no need to process the fuel in order to remove the fission products, and a lowering of power costs is achieved. (T.F.H.)

40392 A REVIEW OF FUEL ELEMENT RESEARCH AND DEVELOPMENT FOR THE HIGH-TEMPERATURE HELIUM GAS-COOLED REACTORS. M. T. Simnad. p.479-509 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

The development of ThC–UC fuel compacts, as well as graphite fuel-element components and materials, is reviewed. Irradiation studies and research on the trapping of fission products within fuel elements are described. Both the fuel and the fuel cladding are assumed to be graphitic. (T.F.H.)

40393 PROCESS DEVELOPMENT FOR THE THORIUM–URANIUM FUEL SYSTEMS. N. H. Katz and M. H. Binstock. p.539-51 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

The resistance of refractory-oxide-coated graphite crucibles to corrosion by Th and Th–U alloys in the liquid state is analyzed. The oxides studied include Y_2O_3, ThO_2, BeO, and ZrO_2. Effects of method of application of the oxide coating are discussed. Properties of castings made from these crucibles are determined, and the amount of C adsorbed by the alloy is measured for each oxide coating. (T.F.H.)

40394 DEVELOPMENT AND TESTING OF FUEL FOR THE CONSOLIDATED EDISON THORIUM REACTOR. L. R. Weissert. p.553-62 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

The manufacturing development and radiation testing of the fuel elements for the Indian Point Power Reactor are outlined. The fuel consists of ThO_2–UO_2 pellets in stainless steel tubes. (T.F.H.)

40395 PRODUCTION AND SINTERABILITY CHARACTERISTICS OF OXIDE MIXTURES OF Th AND U AT LOW CONCENTRATIONS OF U. R. De Leone, S. Ferrari, M. Gabaglio, A. Liscia, and L. Lorenzini. p.563-78 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In Italian)

The coprecipitation characteristics of oxalates, formates, hydroxides, and peroxides of mixtures of U and Th are studied. The calcination and sintering behavior of these precipitates are analyzed, with emphasis on the properties of the mixed ThO_2–UO_2 system formed thereby. (T.F.H.)

40396 MECHANICAL EQUIPMENT IN THE P.C.U.T. PILOT PLANT. O. Drolshagen, F. Gazzabin, and S. Russo. p.579-95 of "Il Ciclo Combustible U–Th." Rome, Comitato Nazionale Energia Nucleare and Florence, Vallecchi, 1962. (In English)

The mechanical equipment and operations involved in remote disassembly, manufacture, and assembly of ThO_2–UO_2 fuel elements composed of fuel-rod bundles are described. The equipment is housed in a pilot-plant reprocessing facility of the Italian P.C.U.T. (Uranium–Thorium Fuel Cycle Program). (T.F.H.)

40397 THE EVOLUTION OF THE UNITED STATES CIVILIAN POWER PROGRAM. A. Giambusso and W. R. Voigt (Atomic Energy Commission, Washington, D. C.). Vienna, International Atomic Energy Agency, 1963, Preprint Paper CN-15/43, 15p. (CONF-69-16)

From Conference on Operating Experience with Power Reactors, Vienna, June 1963.

The elements of major importance in our civilian power program and economics and efficient utilization of nuclear fuel resources are given. Extensive development work will be required by each of these factors, but development work alone, in the absence of successful nuclear power plant operating experience will not suffice. An important start towards this end is being made with water reactors; additional operating experience on these systems will accumulate at an accelerated pace over the next few years. These efforts are producing results inasmuch as utility companies are beginning to undertake the construction of large water reactors on the basis of firm economics. Operating experience with other reactor concepts is now beginning to be accumulated in the U. S. to the extent that these reactor concepts satisfy the requirement of economics, and efficient utilization of nuclear fuel, additional large nuclear power plants employing these reactor concepts will be undertaken by utility companies. (auth)

40398 TRAINING AND LICENSING OF REACTOR OPERATORS AT LICENSED POWER REACTORS. D. J. Skovholt and F. L. Kelly (Atomic Energy Commission, Washington, D. C.). Vienna, International Atomic Energy Agency, 1963, Preprint Paper CN-15/16, 28p. (CONF-69-12)

From Conference on Operating Experience with Power Reactors, Vienna, June 1963.

The regulations and methods used by the U. S. Atomic Energy Commission in the licensing of operators at reactor facilities are described. Data and descriptions are presented on the education, experience, training, and licensing of all applicants, to date, at ten nuclear power generating stations in the United States. It must be noted that the selection and training of personnel at these facilities is prescribed by the facility management. The role of the Regulatory Staff of the Commission is to determine whether these persons, upon application for operators licenses, meet or exceed the standards necessary for safe and competent operation at the prescribed facilities. (auth)

40399 THE STAFFING OF CENTRAL ELECTRICITY GENERATING BOARD NUCLEAR POWER STATIONS. J. S. Bartlett and G. T. Shepherd (Central Electricity Generating Board, London). Vienna, International Atomic Energy Agency, 1963, Preprint CN-15/23, 10p. (CONF-69-13)

From Conference on Operating Experience with Power Reactors, Vienna, June 1963.

The methods of staffing and organizational features of the Central Electricity Generating Board are given. Recruitment and training of personnel for the 230 power stations in England and Wales are explained. (R.E.U.)

40400 INSTALLATION FOR UTILISING THE HEAT PRODUCED IN NUCLEAR REACTORS. (to Escher Wyss AG). British Patent 936,856. Sept. 18, 1963. Priority date Oct. 7, 1958, Switzerland.

Heat produced in a reactor is transferred to the working medium of a thermal power plant by means of a gaseous intermediate heat-transfer medium, which also operates a turbine and compressor. Since the temperature of the heat-transfer medium is too low for high thermodynamic efficiency after the medium has passed through the turbine, two parallel circuits are provided for the heat-transfer medium. The circuit is divided downstream of the reactor, with part of the medium flowing directly to the heat-exchanger of the thermal power plant and the other part flowing to the turbine. (M.P.G.)

40401 IMPROVEMENTS IN LIQUID MODERATED VAPOR SUPERHEAT REACTOR. (to General Electric Co.). British Patent 937,233. Sept. 18, 1963. Priority date Jan. 2, 1959, United States.

Specifications are given for a liquid-moderated vapor superheat reactor. The apparatus includes a reactor vessel, a transverse core-supporting matrix plate, nuclear fuel-containing process tubes, a means for containing the liquid moderator, and a means for introducing the vapor-phase coolant. The nuclear superheat reactor and the fuel-containing process tubes are presented schematically. (R.E.U.)

40402 METHOD AND DEVICE FOR CHARGING A NUCLEAR REACTOR ABOARD A SHIP WITH FUEL ELEMENTS. Werner Spillmann and Fritz Kallipke (to Escher Wyss Aktienges). German Patent 1,149,634. May 30, 1963. Priority date Mar. 22, 1960, Switzerland.

The ship described has a propulsion plant which includes a nuclear reactor, in which the reactor is accommodated in the forward part of the ship and has an outer housing provided with an opening which is closed by a removable cover so that, after removal of the cover, the fuel elements can be introduced and removed through the said opening. The method for servicing the said nuclear reactor comprises running the forward part of the ship beyond its front reactor screen into a chamber screened from the outside, and removing the bow of the ship together with the front screen and the cover of the reactor housing so that fuel elements can be introduced to or removed from the nuclear reactor. (NPO)

40403 WASTE HEAT PLANT WITH SEVERAL WASTE HEAT BOILERS WHICH CONSIST OF A SHELL TUBE THROUGH WHICH THE COOLANT MEDIUM OF A NUCLEAR REACTOR IS CIRCULATED. André Huet. German Patent 1,150,688. June 27, 1963. Priority date Nov. 30, 1956, France.

The waste heat plant described has several waste heat boilers, each of which consists of a shell tube through which the coolant medium of a nuclear reactor is circulated and which contains all the elements necessary for raising steam in a secondary circuit. The steam raising elements, e.g., preheater and superheater elements, are preferably tubes connected parallel to one another. The shell tubes of the boilers have a length of some 10^1m and a diameter of $^1/_{60}$ to $^1/_{50}$ of their length. The tubes of the steam raising elements are helically wound along a common axis so that they are arranged coaxially to each other. The cross section of the flow path for the coolant medium between two of the elements is a function of its distance from the axis. (NPO)

Research Reactors

Refer also to abstract 39980.

40404 (CONF-243-2) FUEL FAILURE DETECTION IN THE HEAVY WATER COMPONENTS TEST REACTOR. E. O. Kiger (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Sept. 20, 1963. Contract AT(07-2)-2. 14p.

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The HWCTR and its cooling system are described briefly. The following four systems for detection of failed fuel elements are described: low-energy gamma monitor, gas fission product monitor, delayed neutron monitor, and scanning liquid photoneutron monitor. Qualitative gamma scans and radionuclide analyses of moderator are used as a backup for the above systems. Other monitors (cyclic air sampling, stack gas activity, and health physics building) are also described. The normal readings of the failure detectors and results of moderator analyses are listed, and experiences during six fuel failures are described. (D.L.C.)

40405 (CONF-243-3) CONTROL OF THE DISSOLVED GASES IN THE MODERATOR OF THE HWCTR. L. M. Arnett (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Sept. 20, 1963. Contract AT(07-2)-1. 7p.

The D_2O moderator and coolant system of the HWCTR is pressurized by helium gas in the top of the pressure vessel, and unexpected reactivity variations due to helium bubbles in the moderator were detected during initial critical experiments. The helium bubbles were caused by aspiration through the control and safety rod assemblies, vortex formation on the D_2O surface, and introduction of the gas from the liquid purge directly into the circulating D_2O. The modifications in the reactor which were made to maintain the gas content of the moderator below saturation

are described. The maximum amount of reactivity held in gas voids after formation of bubbles was eliminated, was observed to be 0.0014 Δk/k, in excellent agreement with that calculated from solubility effects. (D.L.C.)

40406 (IDO-16862) IN-PILE MECHANICAL FAILURE OF MTR FUEL ASSEMBLIES. L. J. Harrison (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 1963. Contract AT(10-1)-205. 45p.

Fuel assembly failures that have occurred as the result of mechanical deficiencies of the assemblies are described. The causes of the failures are analyzed, and measures taken to avoid additional failures are described. (D.C.W.)

40407 (IDO-16905) NUCLEAR START-UP OF THE SPERT IV REACTOR. J. G. Crocker, J. E. Koch, Z. R. Martinson, A. M. McGlinsky, and L. A. Stephan (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 1963. Contract AT(10-1)-205. 41p.

The Spert IV facility, the initial critical experiment, the initial core, the operational core loading, and core parameter measurements (void and temperature coefficients, control rod worth, neutron flux distributions, etc.) made before initiation of the kinetics testing program are described. (auth)

40408 (LA-2854) STATUS REPORT ON THE WATER BOILER REACTOR. Merle E. Bunker (Los Alamos Scientific Lab., N. Mex.). Feb. 1963. Contract W-7405-eng-36. 72p.

The main design features and operating characteristics of the Water Boiler reactor are described. Special emphasis is given to reactor safety and to aspects of the overall operation. (auth)

40409 (NP-13135) CONCERNING THE BACKGROUND IN (n,GAMMA)-EXPERIMENTS AT VVR-S REACTOR. M. I. Cristu and M. S. Popa (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). Apr. 1963. 10p.

An analysis of the background shows the gamma ray, and epithermal neutron contributions. Reduction of the background to minimal levels for (n,γ) experiments is discussed. (auth)

40410 (ORNL-TM-689) OPERATING SAFETY LIMITS FOR THE OAK RIDGE NATIONAL LABORATORY RESEARCH REACTOR (ORR). C. C. Webster (Oak Ridge National Lab., Tenn.). Oct. 11, 1963. Contract [W-7405-eng-26]. 8p.

The Operating Safety Limits designate the limits within which the reactor can be operated safely. The limits specified were determined by design or experience. The limits are listed according to the functional components. Limitations placed on experiments and on administration of the operation are specified. (auth)

40411 (AEC-tr-6067) ALECTO. CALCULATION OF THE DOSE RECEIVED IN THE CASE OF A CRITICAL EXCURSION OF 10^{18} FISSIONS. J. P. Barthe (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Fontenay-aux-Roses). Translated from Oak Ridge National Lab., Tenn., from report DEP/SEPP/143/61. Feb. 1961. 7p.

The calculation shows that the exception of the hall very close to the reactor, the dose of scattered neutrons is extensively greater than the dose due to direct neutrons and γ rays. A method is described which permitted the dose of scattered neutrons to be calculated by means of a more or less pessimistic hypothesis at several points of the hall, the cabin, and the way along the cabin. (auth)

40412 (EURAEC-608) SURVEY OF THE SAFETY OF THE "EURATOM" EXPERIMENT—STUDY OF URANIUM AND PLUTONIUM FUELS IRRADIATED BY OSCILLATION IN MINERVE. Special Report No. 4. M. Robin and R. Vidal (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Fontenay-aux-Roses). Nov. 1962. Work Performed under United States–Euratom Joint Research and Development Program. 53p. (A translation)

In the research program on plutonium recycling, oscillation measurements are to be made in MINERVE. In these measurements, a tight tank containing a lattice portion of a heavy water pile will be placed into the central cavity of MINERVE, and a continuous uranium train will be passed through the pile to oscillate the neutron spectrum. Some of the fuels will be fresh fissile materials, while others will have been irradiated. A description is given of the installation and planned experiments, and the safety of the experiments is reviewed. (D.L.C.)

40413 "PROJECT ESCALATE" UCLA PLANS TO UPGRADE PERFORMANCE OF THE ARGONAUT. R. D. MacLain (Univ. of California, Los Angeles). Res. Reactor J., 3: No. 4, 1-5(1963).

Plans were made to convert the UCLA Argonaut-type reactor into what might be called a "Super Juggernaut" with a in-core thermal neutron flux of 2×10^{14}. The modifications made for operation at 100 kw are described, and a design study was made to explore the feasibility of further power increases. The planned schedule of power increases in Project Escalate and the planned ancillary improvements in the reactor laboratory are described. (D.L.C.)

40414 THE UCLA FLUX TRAP CORE. A DESIGN STUDY. R. D. MacLain (Univ. of California, Los Angeles). Res. Reactor J., 3: No. 4, 6-9(1963).

A review is given of a design evolution of the proposed second core for the UCLA Argonaut, which is to be modified for operation to yield a peak neutron flux of 2×10^{14}. The design criteria and tne solutions to the problems of installing a flux trap in the center island and rebuilding the core and reflector are outlined. The characteristics and reactivity investments of the core are tabulated. Finally, its safety is considered. (D.L.C.)

SPACE APPLICATIONS AND TECHNOLOGY

Refer also to abstract 39007.

40415 (NAA-SR-Memo-8440) CORE TRANSFER FUNCTION MODELS FOR SNAP SYSTEM KINETICS. R. L. Johnson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 29, 1963. Contract [AT(11-1)-Gen-8]. 34p.

A distributed parameter transfer function is developed for SNAP type reactor cores. The coolant may be either boiling, non-boiling, or both. In the boiling case the Bankoff model is used to find the spatial distribution of voids. The transfer functions obtained are not simple polynomials. However, they are readily analyzed for stability using the 7090 program TRAFIC, which uses a Nyquist diagram approach. Some general conclusions resulting from these calculations are included. (auth)

WASTE DISPOSAL AND PROCESSING

Refer also to abstracts 39180, 39296, 39297, 39298, and 39302.

40416 (ORNL-2611) FIXATION OF FISSION PRODUCTS IN ALUMINUM NITRATE WASTES BY CERAMIC MASSES. (Oak Ridge National Lab., Tenn.). Oct. 11, 1963. Contract W-7405-eng-26. 28p.

The retention of fission products by ceramics prepared by firing mixtures of natural clays with a synthetic aluminum nitrate waste solution was studied. Compositions based on Ottosee shale, tailings from washing phosphate rock, and attapulgites show promise for fixing fission products. Further development is required to establish adequate retention of cesium. A preliminary study was made of the chemical and physical processes leading to fixation of fission products by these ceramics. (auth)

40417 (ORNL-TM-619) ENGINEERING STUDIES ON POT CALCINATION FOR ULTIMATE DISPOSAL OF NUCLEAR WASTE FROM TBP-25, DAREX, AND PUREX PROCESSES. PART II. COLLECTION OF PERFORMANCE DATA AND ANALYSIS. C. W. Hancher, L. J. King, J. C. Suddath, and M. E. Whatley (Oak Ridge National Lab., Tenn.). Sept. 20, 1963. Contract [W-7405-eng-26]. 310p.

Experience with the operation of an experimental engineering-development pot-calcination facility, including two types of evaporators with associated control systems and a calciner pot up to 8 in. in diameter and 90 in. high, formed the basis for the recommendation of equipment and operating procedures for the hot-pilot-plant phase of the waste-calcination program. The operating data and results from about 20 runs are shown in tables and graphs, and significant operating variables are discussed. A continuous waste evaporator with a 25-liter operating volume, a batch evaporator with a capacity of 500 liters, and waste calciner pot with a 60-liter operating capacity were operated to obtain the necessary data to facilitate the design of the pot-calcination pilot plant. The three types of feed used were Purex, TBP-25, and Darex. The average feed rates varied from a low of 7.0 liters/hr to a maximum of 30.6. The total feed volume calcined varied from 325 to 641 liters. The reduction in volume for the Purex waste was about 10 to 1, and for TBP-25 and Darex the reduction was about 8 to 1. The volume ratio of water added to strip the nitric acid from the evaporator to feed volume varied from 2.0:1.0 to 4.1:1.0. The resulting calcined solids had bulk densities of about 0.6 g/cc for TBP-25 waste, about 1.2 g/cc for Darex, and about 1.25 g/cc for Purex. The pot-calcination process is a simple direct approach for preparing high-activity liquid wastes for ultimate disposal, as it requires a small number of processing steps. It is versatile enough to handle a variety of fuel processing wastes, for example, Purex, TBP-25, and Darex, and it produces a small volume of off-gas to be processed for recycle or disposal to the environment. (auth)

40418 CALCINATION OF RADIOACTIVE WASTES. Brit. Chem. Eng., 8: 701-3(Oct. 1963).

Progress on the various processes of waste calcination now being developed in U.S.A. is reviewed. These processes are: calcination in molten sulfur, fluidized-bed calcination, ball kiln calcination, continuous phosphate glass process, pot calcination, radiant spray calcination, and ceramic sponge process. (D.L.C.)

40419 THE WASTE PROCESSING PLANT. ITS PROBLEMS, OPERATION, AND RESULTS. N. Fernandez. Energie Nucl., 5: 282-90(June 1963). (In French)

The necessity for waste processing in a Pu extraction plant and the difficulties encountered in the chemical process chosen are described. The equipment used in the plant was not specially designed, but was commercially available. The process used is described. The results obtained are satisfactory, with removal of the most dangerous radioisotopes and 19/20 of the total radioactivity received at the plant. A modification being made to the process (reduction of the volume to be treated by recirculation and coating of the sludge with bitumen) are discussed. (J.S.R.)

40420 FIXATION OF RADIOACTIVE COMPONENTS. (to M. W. Kellogg Co.). British Patent 936,920. Sept. 18, 1963. Priority date Sept. 10, 1959, United States.

A process for the incorporation of radioactive waste materials in a water-unleachable solid is patented. A mixture of solids containing the radioactive waste, a metal oxide, and an element capable of forming a stable oxide and is polyvalent in the combined state is heated to the temperature at which reaction between the metal oxide and the element is initiated. At the completion of the reaction, a rock-like product is obtained, in which the radioactive waste, metal oxide, and the oxide of the element are chemically combined in a complex compound. The most preferred metal oxide reactants for the reaction are the higher oxides of Fe, Pb, Mn, Cu, and Ni, and the most preferred polyvalent elements are Zr, Al, and Si. (M.P.G.)

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

ä	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

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As an aid to the users of this index, references to report numbers, where appropriate, are included after the abstract number of the citation.

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2	17-39519	ORINS
3	17-39080	ORINS
4	17-39169	ORINS
5	17-39167	ORINS
6	17-39168	ORINS
7	17-39170	ORINS
9	17-39209	ORINS
10	17-39081	ORINS
CONF-208–	**(International Symposium on Local Properties of Perfect Crystals, Geneva, July 1962)**	
1	17-39708	See ARL-62-459
CONF-209–	**(American Vacuum Society Meeting, Boston, October 1963)**	
1	17-39223	See UCRL-7399-T
2	17-39222	See UCRL-7393

Report No.	Abstract No.	Availability
CONF-210–	**(Conference on Nuclear Physics, Orsay, France, May 1963)**	
1	17-39965	See BLG-173
CONF-213–	**(Symposium on Water Chemistry in Reactors, Rome, May 1963)**	
1	17-39094	See AECL-1800
CONF-215–	**(6th Congress of Nutrition, Edinburgh, Scotland, August 1963)**	
1	17-38704	See BNL-7252
CONF-216–	**(International Conference on Elementary Particles, Siena, Italy, Sept. 30–Oct. 5, 1963)**	
1	17-39844	See BNL-7258
CONF-217–	**(Radiation Research Society 11th Annual Meeting, Milwaukee, May 1963)**	
1	17-38885	See SAM-TDR-63-40
CONF-218–	**(Symposium on Statistical Properties of Atomic and Nuclear Spectra, Stony Brook, N. Y., May 1963)**	
1	17-39968	See BNL-7234
2	17-39452	See BNL-7215
CONF-221–	**(4th Uranium Carbide Meeting, East Hartford, Conn., May 1963)**	
1	17-39027	See UCRL-7362-T
CONF-224–	**(The Faraday Society, General Discussions, Fundamental Processes in Radiation Chemistry Conference, Notre Dame, Ind., September 1963)**	
2	17-39097	Dep.(mc); $1.10(fs), $0.80(mf) OTS
3	17-39107	See TID-18777
5	17-39098	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6	17-39099	Dep.(mc); $1.10(fs), $0.80(mf) OTS
7	17-39100	Dep.(mc); $1.60(fs), $0.80(mf) OTS
8	17-39150	ORINS
9	17-39161	ORINS
10	17-39160	ORINS
11	17-39159	ORINS
12	17-39157	ORINS
13	17-39149	ORINS
14	17-39156	ORINS
15	17-39151	ORINS
16	17-39152	ORINS
17	17-39153	ORINS
18	17-39154	ORINS
19	17-39148	ORINS
20	17-39162	ORINS
21	17-39158	ORINS
CONF-225–	**(American Institute of Chemical Engineers 51st National Meeting, San Juan, P. R., Sept.–Oct. 1963)**	
1	17-39255	New York, American Institute of Chemical Engineers, 1963, Preprint 22, $0.50; ORINS
2	17-39256	New York, American Institute of Chemical Engineers, 1963, Preprint 21, $0.50; ORINS
3	17-39258	New York, American Institute of Chemical Engineers, 1963, Preprint 20, $0.50; ORINS
4	17-39252	New York, American Institute of Chemical Engineers, 1963, Preprint 19, $0.50; ORINS
5	17-39253	New York, American Institute of Chemical Engineers, 1963, Preprint 18, $0.50; ORINS
6	17-39257	New York, American Institute of Chemical Engineers, 1963, Preprint 5, $0.50; ORINS
7	17-39249	New York, American Institute of Chemical Engineers, 1963, Preprint 4, $0.50; ORINS
8	17-39250	New York, American Institute of Chemical Engineers, 1963, Preprint Paper 3, $0.50; ORINS
9	17-39251	New York, American Institute of Chemical Engineers, 1963, Preprint Paper 1, $0.50; ORINS
CONF-226–	**(5th Biennial Gas Dynamics Symposium, Evanston, Ill., August 1963)**	
1	17-40205	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-388, $1.00; ORINS
2	17-40211	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-386, $1.00; ORINS
3	17-40214	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-385, $1.00; ORINS
5	17-40152	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-382, $1.00; ORINS
6	17-40207	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-378, $1.00; ORINS
7	17-40206	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-377, $1.00; ORINS
8	17-40204	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-375, $1.00; ORINS
9	17-40208	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-374, $1.00; ORINS
10	17-40210	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-373, $1.00; ORINS
11	17-40213	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-372, $1.00; ORINS
12	17-40202	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-371, $1.00; ORINS
13	17-39813	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-368, $1.00; ORINS
14	17-40212	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-369, $1.00; ORINS
15	17-40209	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-367, $1.00; ORINS
16	17-40203	New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63-380, $1.00; ORINS
CONF-228–	**(International Association of Geomagnetism and Aeronomy, 13th General Assembly of the International Union of Geodesy and Geophysics, Berkeley, Calif., August 1963)**	
1	17-40131	ORINS
CONF-231–	**(International Conference on Fundamental Aspects of Weak Interactions, Upton, N. Y., September 1963)**	
1	17-39847	See UCRL-11018
CONF-232–	**(International Colloquy on Neutron Diffusion and Diffraction, Grenoble, France, September 1963)**	
1	17-39714	See BNL-7325

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CONF-233–	**(Conference on the Role of Atomic Electrons in Nuclear Transformations, Warsaw, September 1963)**	
1	17-39969	See BNL-7333
CONF-237–	**(7th Symposium on Hydrogen Thyratrons and Modulators, Fort Monmouth, N. J., May 1962)**	
1	17-40164	See UCRL-6811
CONF-243–	**(American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Canada, October 1963)**	
1	17-40263	Dep.(mc); $1.10(fs), $0.80(mf) OTS
2	17-40404	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3	17-40405	Dep.(mc); $1.10(fs), $0.80(mf) OTS
CONF-244–	**(American Society of Animal Science, Western Section, Laramie, Wyo., July 1962)**	
1	17-38705	Dep.(mc); $1.10(fs), $0.80(mf) OTS
CRRD–	**(Canadian)**	
1161	17-39412	Dep.; $0.50(AECL)
CU(PNPL)–		
227	17-38583	Dep.; $2.75(OTS)
CVNA–	**(Misc.)**	
189	17-40337	Dep.(mc); $3.60(fs), $1.19(mf) OTS
DASA–	**(Misc.)**	
618	17-38613	$1.60(OTS)
DEP/SEPP–	**(French)**	
42-60	17-40217	For translation see AEC-tr-6044
50	17-39950	For translation see AEC-tr-6040
143/61	17-40411	For translation see AEC-tr-6067
146-61	17-39955	For translation see AEC-tr-6070
156/61	17-40285	For translation see AEC-tr-6066
158-61	17-40219	For translation see AEC-tr-6058
204bis/62	17-39952	For translation see AEC-tr-6057
205/62	17-39954	For translation see AEC-tr-6062
226/62	17-39953	For translation see AEC-tr-6061
232/62	17-40218	For translation see AEC-tr-6051
246/62	17-40220	For translation see AEC-tr-6063
263/63	17-39951	For translation see AEC-tr-6055
CAB-03-63	17-40284	For translation see AEC-tr-6060
DESY-A–	**(German)**	
2.100	17-40142	Dep.(mc)
2.102	17-39374	Dep.(mc)
DMIC-Memo–	**(Non-AEC)**	
169	17-39498	$0.75(OTS)
DP–		
306	17-39499	Dep.(mc); $1.60(fs), $0.80(mf) OTS
840	17-38918	Dep.; $0.50(OTS)
DPSPU–		
62-30-12A	17-39172	Dep.(mc); $1.60(fs), $0.80(mf) OTS p.69-75 of "Nuclear Safety." Vol. 5, No. 1, 1963.
DRI–	**(Misc.)**	
2117	17-39529	Dep.(mc); $1.10(fs), $0.80(mf) OTS
EANDC–	**(European-American Nuclear Data Committee)**	
28(L)	17-39970	Dep.(mc)
EANDC(E)–	**(European-American Nuclear Data Committee)**	
47(L)	17-39971	Dep.(mc)

Report No.	Abstract No.	Availability
EE–		
15	17-40165	See USCEC-82-205
EFINS–	**(Misc.)**	
62-27	17-38655	Ann. N. Y. Acad. Sci., 108: 514-33(1963)
62-28	17-38654	Ann. N. Y. Acad. Sci., 108: 495-513(1963)
62-70	17-38676	Science, 138: 1392-9(1962)
EIR–	**(Swiss)**	
52	17-39972	Dep.(mc)
ERS–		
131	17-39360	See TID-17886
EUR–	**(European Atomic Energy Community)**	
118.f	17-38919	Dep.(mc)
205.f	17-39973	Dep.(mc)
303.i	17-39237	Dep.(mc)
375.d	17-40264	Dep.(mc)
381.f	17-39124	J. Chim. Phys., No. 4, 505-9(1963)
390.e	17-38651	Ann. Human Genet., 26: 383-405(1963)
407.f	17-39286	Dep.(mc)
EURAEC–		
267	17-39497	See ATL-A-138
429	17-39467	Dep.(mc); $1.10(fs), $0.80(mf) OTS
462	17-39505	Dep.(mc); $1.60(fs), $0.80(mf) OTS
520	17-39468	Dep.(mc); $4.60(fs), $1.52(mf) OTS
539	17-39506	Dep.(mc); $1.10(fs), $0.80(mf) OTS
563	17-39544	Dep.(mc); $7.60(fs), $2.54(mf) OTS
591	17-39375	Dep.(mc); $4.60(fs), $1.43(mf) OTS
599	17-39545	Dep.(mc); $1.60(fs), $0.80(mf) OTS
600(Pt.3)	17-39546	Dep.(mc); $2.60(fs), $0.95(mf) OTS
601	17-39507	Dep.(mc); $1.60(fs), $0.80(mf) OTS
602	17-39469	Dep.(mc); $1.60(fs), $0.80(mf) OTS
603	17-40265	Dep.(mc); $5.60(fs), $1.97(mf) OTS
608	17-40412	Dep.(mc); $5.60(fs), $1.79(mf) OTS
609	17-39419	Dep.(mc); $1.10(fs), $0.80(mf) OTS
610	17-39679	Dep.(mc); $1.60(fs), $0.80(mf) OTS
611	17-39481	Dep.(mc); $1.60(fs), $0.80(mf) OTS
614	17-39508	Dep.(mc); $1.10(fs), $0.80(mf) OTS
615	17-39509	Dep.(mc); $14.00(fs), $6.23(mf) OTS
616	17-39482	Dep.(mc); $3.60(fs), $1.19(mf) OTS
617	17-39510	Dep.(mc); $8.60(fs), $3.08(mf) OTS
619	17-39470	Dep.(mc); $3.60(fs), $1.34(mf) OTS
623	17-39243	Dep.(mc); $1.10(fs), $0.80(mf) OTS
630	17-39238	Dep.(mc); $6.60(fs), $2.06(mf) OTS
636	17-39547	Dep.(mc); $2.60(fs), $0.89(mf) OTS
646	17-39548	Dep.(mc); $6.60(fs), $2.30(mf) OTS
648	17-39471	Dep.(mc); $4.60(fs), $1.61(mf) OTS
650	17-39530	Dep.(mc); $4.60(fs), $1.49(mf) OTS
659	17-39511	Dep.(mc); $4.60(fs), $1.58(mf) OTS
660	17-39483	Dep.(mc); $3.60(fs), $1.25(mf) OTS
667	17-39512	Dep.(mc); $6.60(fs), $2.15(mf) OTS
668	17-39472	Dep.(mc); $2.60(fs), $0.89(mf) OTS
672	17-39513	Dep.(mc); $4.60(fs), $1.46(mf) OTS
673	17-39663	Dep.(mc); $5.60(fs), $1.97(mf) OTS
688	17-39484	Dep.(mc); $2.60(fs), $0.86(mf) OTS
689	17-39531	Dep.(mc); $9.60(fs), $3.53(mf) OTS
693	17-39532	Dep.(mc); $6.60(fs), $2.30(mf) OTS
696	17-40286	Dep.(mc); $3.60(fs), $1.37(mf) OTS
698	17-39549	Dep.(mc); $1.60(fs), $0.80(mf) OTS
699	17-39514	Dep.(mc); $1.60(fs), $0.80(mf) OTS
700	17-39382	Dep.(mc); $1.10(fs), $0.80(mf) OTS
704	17-39491	Dep.(mc); $9.60(fs), $3.53(mf) OTS
705	17-39473	Dep.(mc); $4.60(fs), $1.58(mf) OTS
710	17-38923	Dep.(mc); $1.60(fs), $0.80(mf) OTS
712	17-39239	Dep.(mc); $7.60(fs), $2.45(mf) OTS
726	17-39492	Dep.(mc); $2.60(fs), $0.95(mf) OTS
727	17-39533	Dep.(mc); $3.60(fs), $1.31(mf) OTS
728	17-40266	Dep.(mc); $1.60(fs), $0.80(mf) OTS

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738	17-39485	Dep.(mc); $1.60(fs), $0.80(mf) OTS
745	17-39664	Dep.(mc); $1.60(fs), $0.80(mf) OTS
747	17-39486	Dep.(mc); $2.60(fs), $0.86(mf) OTS
750	17-40267	Dep.(mc); $1.60(fs), $0.80(mf) OTS
757	17-39493	Dep.(mc); $9.10(fs), $3.32(mf) OTS
769	17-39515	Dep.(mc); $1.60(fs), $0.80(mf) OTS
774	17-39665	Dep.(mc); $1.60(fs), $0.80(mf) OTS
775	17-40268	Dep.(mc); $3.60(fs), $1.25(mf) OTS
791	17-39534	Dep.(mc); $1.60(fs), $0.80(mf) OTS
798	17-40269	Dep.(mc); $2.60(fs), $0.89(mf) OTS
F–	**(Misc.)**	
A2392-02	17-40274	See NYO-9672
B1933	17-39540	See NP-13145
FN-E–	**(Italian)**	
36	17-39665	See EURAEC-774
FTD-TT–	**(Non-AEC)**	
62-1678	17-39474	OTS
FZK–	**(Non-AEC)**	
9-182	17-39947	See NARF-63-3T
9-186	17-39948	See NARF-63-5T
GA–	**(Misc.)**	
3683	17-39500	Dep.(mc); $3.60(fs), $1.31(mf) OTS
3856	17-39535	Dep.(mc); $1.60(fs), $0.80(mf) OTS
4176	17-39943	Dep.(mc); $5.60(fs), $1.82(mf) OTS
4506	17-40131	See CONF-228-1
GEAP–	**(Misc.)**	
3967(Rev.)	17-40338	Dep.; $1.00(OTS)
4217	17-40339	Dep.(mc); $1.60(fs), $0.80(mf) OTS
4240	17-40270	Dep.(mc); $10.10(fs), $3.95(mf) OTS
4301	17-40271	Dep.(mc); $4.60(fs), $1.58(mf) OTS
4309	17-40340	Dep.(mc); $8.10(fs), $2.63(mf) OTS
4310	17-39487	Dep.(mc); $5.60(fs), $1.88(mf) OTS
GEST–	**(Misc.)**	
2021	17-39717	
GNEC–		
141(Del.)	17-40341	Dep.(mc); $15.00(fs), $7.07(mf) OTS
HASL–		
140	17-39287	Dep.; $4.00(OTS)
HNS–		
17	17-39266	Dep.(mc); $3.60(fs), $1.16(mf) OTS
24	17-39267	Dep.(mc); $4.60(fs), $1.64(mf) OTS
HW–		
63552	17-39376	$1.10(fs), $0.80(mf) OTS
68600-30	17-38614	Dep.; $0.50(OTS)
68600-31	17-38615	Dep.; $0.50(OTS)
69871	17-39944	$2.60(fs), $0.92(mf) OTS
71570	17-39264	Dep.; $1.00(OTS)
72191	17-39377	Dep.(mc); $1.60(fs), $0.80(mf) OTS
75092	17-39413	Dep.(mc); $1.60(fs), $0.80(mf) OTS
75943	17-39101	Dep.(mc); $1.60(fs), $0.80(mf) OTS
76263	17-39666	Dep.; $1.50(OTS)
76351(Rev.)	17-39288	Dep.; $0.50(OTS)
77855	17-39667	Dep.(mc); $1.60(fs), $0.80(mf) OTS
78424	17-39536	Dep.; $1.60(fs), $0.80(mf) OTS
78574	17-39501	Dep.; $0.75(OTS)
HW-SA–		
2344	17-39001	p.50-8 of Proc., Intern. Conf., Mod. Trends Activation Anal., College Station, Tex.
2955	17-38765	Am. J. Pathol., 43: 527-37(1963)
3058	17-40109	Phys. Rev., 132: 807-12(1963)
IA–	**(Non-AEC)**	
872	17-39796	Spectrochim. Acta, 19: 1615-16(1963)
IDO–		
14612	17-39215	Dep.; $0.50(OTS)
16862	17-40406	Dep.; $1.25(OTS)
16878	17-39378	Dep.; $0.50(OTS)
16905	17-40407	Dep.; $1.00(OTS)
IEA–	**(Non-AEC)**	
60	17-38920	Dep.(mc)
IITRI–	**(Misc.)**	
B6012-2	17-39537	
INSJ–	**(Japanese)**	
59	17-39974	Dep.(mc)
IS–		
620	17-40252	Rev. Mod. Phys., 35: 448-56(1963)
665	17-39021	Dep.; $0.50(OTS)
710	17-40093	Phys. Letters, 6: 219-22(1963)
JPL-TR–	**(Non-AEC)**	
32-333	17-40272	
32-508	17-39240	
JPRS–	**(Non-AEC)**	
20375(p.5-8)	17-38750	OTS
21241	17-40350	$0.50(OTS)
JüL–	**(German)**	
92-RC	17-39074	Z. Naturforsch., 17a: 820(1962)
93-RC	17-39073	Z. Anal. Chem., 191: 416-29(1962)
KFK–	**(German)**	
147	17-38917	Z. Elektrochem., 67: 219-28(1963)
LA–		
2854	17-40408	Dep.; $1.75(OTS)
2940	17-40159	Dep.; $0.50(OTS)
LADC–		
5655	17-39610	Trans. AIME, 227: 1151-5(1963)
5682	17-39680	Acta Met., 11: 1129-38(1963)
5844	17-39216	Dep.(mc); $1.60(fs), $0.80(mf) OTS
LAMS–		
2941	17-39975	Dep.; $2.25(OTS)
2948	17-39488	Dep.; $0.75(OTS)
2952	17-39022	Dep.; $0.50(OTS)
2973	17-40342	Dep.; $0.50(OTS)
LP–	**(Misc.)**	
26	17-40156	See ARL-63-182
MDL–	**(Non-AEC)**	
Q2	17-38616	$6.60(OTS)
MND–	**(Misc.)**	
2934	17-39718	$8.60(OTS)
2945-3	17-39719	$6.60(OTS)
MR–	**(Non-AEC)**	
34	17-39670	See NP-13155
MR-N–	**(Non-AEC)**	
298	17-39976	See NARF-62-17T
299	17-39103	See NARF-63-4T

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302	17-39669	See NARF-63-6T
MRC–	**(Misc.)**	
386	17-39460	Dep.(mc); $3.60(fs), $1.19(mf) OTS
MSAR–	**(Misc.)**	
63-125	17-39538	Dep.(mc); $3.60(fs), $1.13(mf) OTS
N–	**(Misc.)**	
62-11316	17-39668	$3.60(fs), $1.31(mf) OTS
NAA-SR–		
8377	17-39720	Dep.; $1.00(OTS)
8403	17-39462	Dep.; $0.50(OTS)
8431	17-40343	Dep.; $0.75(OTS)
8538	17-39539	Dep.; $0.50(OTS)
NAA-SR-Memo–		
2957	17-39102	Dep.(mc); $1.10(fs), $0.80(mf) OTS
8347	17-39461	Dep.(mc); $3.60(fs), $1.16(mf) OTS
8440	17-40415	Dep.(mc); $3.60(fs), $1.22(mf) OTS
8516(Rev.)	17-40216	Dep.(mc); $10.10(fs), $3.92(mf) OTS
8582	17-39217	Dep.(mc); $3.60(fs), $1.40(mf) OTS
8670	17-39218	Dep.(mc); $1.10(fs), $0.80(mf) OTS
8675	17-40273	Dep.(mc); $1.60(fs), $0.80(mf) OTS
8728	17-39219	Dep.(mc); $2.60(fs), $0.95(mf) OTS
8742	17-39945	Dep.(mc); $12.50(fs), $5.45(mf) OTS
8823	17-39946	Dep.(mc); $9.60(fs), $3.74(mf) OTS
8902	17-39379	Dep.(mc); $1.10(fs), $0.80(mf) OTS
8915	17-39289	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NARF–	**(Non-AEC)**	
62-17T	17-39976	$8.10(OTS)
63-3T	17-39947	$4.60(OTS)
63-4T	17-39103	$8.60(OTS)
63-5T	17-39948	$6.60(OTS)
63-6T	17-39669	$2.60(OTS)
NASA-SP–	**(Non-AEC)**	
3003	17-39671	$2.50(OTS)
NAVDOCKS-P–	**(Non-AEC)**	
290	17-39290	$1.50(GPO)
NLCO–		
886	17-39502	Dep.; $0.50(OTS)
NMI–	**(Misc.)**	
2119	17-39463	Dep.(mc); $1.60(fs), $0.80(mf) OTS
NP–	**(AEC File No. for Non-AEC Reports)**	
13076	17-39104	
13077	17-39105	
13087	17-39291	
13102	17-40143	Dep.(mc)
13113	17-39977	
13114	17-39845	
13115	17-38732	
13116	17-39489	
13117	17-39949	
13118	17-39292	Dep.(mc)
13122	17-39464	$8.60(OTS) as AD-421136
13123	17-40344	Dep.(mc)
13125	17-39023	
13128	17-38617	Dep.(mc)
13133	17-39672	
13134	17-39978	Dep.(mc)
13135	17-40409	Dep.(mc)
13136	17-40160	
13137	17-39673	
13139	17-39982	$11.50(OTS) as AD-421551
13145	17-39540	
13148	17-39721	
13150	17-38618	$3.60(OTS) as AD-420656
13151	17-39293	
13152	17-40144	
13153	17-40161	Dep.(mc)
13155	17-39670	
NP-tr–	**(AEC File No. for Non-AEC Translations)**	
1062	17-40147	Dep.(mc); $3.60(fs), $1.28(mf) JCL or OTS
NRL–	**(Misc.)**	
5967	17-39722	$3.60(OTS)
NYO–		
9539	17-39979	Dep.(mc); $2.60(fs), $0.89(mf) OTS
9672	17-40274	Dep.(mc); $8.10(fs), $2.63(mf) OTS
9703-07	17-40333	See ACNP-6125(Suppl. 1)
10516(Vol.I)	17-40334	See ACNP-63809(Vol.I)
10516(Vol.II)	17-40335	See ACNP-63809(Vol.II)
10555	17-39380	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10595	17-38583	See CU(PNPL)-227
10602	17-38742	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10606	17-39503	Dep.(mc); $1.60(fs), $0.80(mf) OTS
ORNL–		
2611	17-40416	Dep.; $0.75(OTS)
3452	17-39177	Dep.; $3.50(OTS)
3474	17-39490	Dep.; $0.75(OTS)
3490	17-39294	Dep.; $2.00(OTS)
3492	17-39295	Dep.; $3.00(OTS)
ORNL-TM–		
91	17-39541	Dep.(mc); $3.60(fs), $1.40(mf) OTS
619	17-40417	Dep.(mc); $19.75(fs), $9.26(mf) OTS
666	17-39980	Dep.(mc); $2.60(fs), $0.92(mf) OTS
670	17-39173	Dep.(mc); $1.10(fs), $0.80(mf) OTS
671	17-39174	Dep.(mc); $1.10(fs), $0.80(mf) OTS
673	17-39175	Dep.(mc); $1.60(fs), $0.80(mf) OTS
674	17-39220	Dep.(mc); $2.60(fs), $1.01(mf) OTS
675	17-39504	Dep.(mc); $1.60(fs), $0.80(mf) OTS
676	17-39176	Dep.(mc); $1.10(fs), $0.80(mf) OTS
677	17-39315	Dep.(mc); $7.60(fs), $2.54(mf) OTS
686	17-39842	Dep.(mc); $1.10(fs), $0.80(mf) OTS
689	17-40410	Dep.(mc); $1.10(fs), $0.80(mf) OTS
690	17-40275	Dep.(mc); $1.60(fs), $0.80(mf) OTS
ORO–		
599	17-39268	Dep.; $0.50(OTS)
OTS–	**(Misc.)**	
63-31393(p.5-8)	17-38750	For translation see JPRS-20375(p.5-8)
63-31837	17-40350	For translation see JPRS-21241
PAN–	**(Polish)**	
425/XIV	17-39024	Dep.
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
906,856	17-40400	
932,430	17-39478	
932,802	17-40215	
933,510	17-40315	
933,573	17-39404	
933,794	17-39234	
933,822	17-39405	
933,984	17-39660	
934,221	17-40316	
934,242	17-40225	
934,293	17-39235	
934,343	17-40317	
934,471	17-40318	

Report No.	Abstract No.	Availability
934,734	17-39211	
935,380	17-39093	
936,165	17-39368	
936,198	17-40319	
936,205	17-40320	
936,210	17-39163	
936,421	17-39450	
936,451	17-40321	
936,452	17-40322	
936,453	17-40323	
936,454	17-40324	
936,455	17-40325	
936,514	17-39479	
936,861	17-39406	
936,903	17-40326	
936,920	17-40420	
937,034	17-40327	
937,126	17-39520	
937,233	17-40401	
937,274	17-40328	
937,314	17-39164	
937,337	17-40329	
937,406	17-40330	
PATENTS	**(German)**	
1,148,533	17-39171	
1,149,134	17-38699	
1,149,155	17-39521	
1,149,634	17-40402	
1,149,829	17-39448	
1,150,369	17-39212	
1,150,688	17-40403	
1,150,763	17-40331	
1,151,885	17-40332	
PATENTS	**(U.S.S.R.)**	
152,957	17-39213	
PG-Report–	**(British)**	
173(Rev.)	17-40276	Dep.; $0.60(BIS); 3s. (HMSO)
Q–	**(Misc.)**	
A2392-3-9	17-39221	See TID-19476
R–	**(Misc.)**	
2218	17-39481	See EURAEC-611
2231	17-39664	See EURAEC-745
63SD76	17-39723	
RCC-R–	**(British)**	
165	17-39316	Dep.; $0.30(BIS); 1s. 9d. (HMSO)
REIC-ACCESS–	**(Non-AEC)**	
67	17-39674	$2.60(OTS)
68	17-39675	$4.60(OTS)
RFP–		
330	17-38921	Dep.(mc); $1.60(fs), $0.80(mf) OTS
RHD–	**(Non-AEC)**	
Vol.4, No.7	17-39347	Public Health Service, Washington, D. C.; $0.50(GPO)
SAM-TDR–	**(Non-AEC)**	
63-13	17-38743	$1.10(OTS)
63-25	17-39414	$1.60(OTS)
63-40	17-38885	
SB–	**(Non-AEC)**	
62-32	17-39459	See AD-296351
62-34	17-39408	See AD-296353

Report No.	Abstract No.	Availability
SC–	**(Misc.)**	
4796(RR)	17-39724	Dep.(mc); $6.60(fs), $2.03(mf) OTS
SC-T–		
510	17-39030	Dep.(mc); $1.10(fs), $0.80(mf) OTS
SCDC–		
3035	17-38931	See TID-17989
3237	17-39739	See TID-18799
SCNC–	**(Misc.)**	
328(Del.)	17-39465	Dep.(mc); $2.60(fs), $1.01(mf) OTS
SCR–		
672	17-39676	Dep.(mc); $5.60(fs), $1.94(mf) OTS
676	17-39681	Appl. Phys. Letters, 2: 235-6(1963)
692	17-40162	Dep.(mc); $2.60(fs), $0.86(mf) OTS
SCTM–		
369-59(51)	17-38922	Dep.(mc); $2.60(fs), $0.89(mf) OTS
SGAE–	**(Austrian)**	
1963/2	17-39106	Dep.(mc)
SM–	**(Misc.)**	
42/28	17-40262	See BNL-7293
STI-DOC–	**(International Atomic Energy Agency)**	
10/18	17-38966	Analytical Chemistry of Nuclear Materials. $2.00; Sch 42; 12s.stg; F.fr.8, DM 6,40 (IAEA)
TID–		
3719	17-38627	Dep.; Free (DTI Extension)
3913	17-38631	Dep.; $0.75(OTS)
7024	17-40277	Dep.; $5.00(OTS)
7648(Pt.I)	17-40278	Dep.; $3.00(OTS)
13560	17-38991	Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 527-39(1963)
13734	17-38974	Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 99-109(1963)
14075	17-38979	Advan. Mass. Spectrometry, 2: Proc. Conf. Oxford, 1961, 198-205(1963)
15922	17-39166	International Series of Monographs on Nuclear Energy. Division IX. Chemical Engineering. Volume 2. Oxford, Pergamon Press, 1963
16806	17-38935	Anal. Chim. Acta, 29: 211-14(1963)
16964	17-38915	Ann. N. Y. Acad. Sci., 108: 128-46(1963)
17607	17-39892	Nuovo Cimento (10), 29: 298-301(1963)
17886	17-39360	Dep.(mc); $2.60(fs), $1.07(mf) OTS
17989	17-38931	Anal. Chem., 35: 1766-8(1963)
18120	17-39428	Commun. ACM (Assoc. Computing Machinery), 6: 332-5(1963)
18548	17-40052	Nucl. Phys., 47: 212-24(1963)
18704	17-39455	Phys. Rev., 132: 930-1(1963)
18777	17-39107	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18799	17-39739	J. Chem. Phys., 39: 1827-32(1963)
18832	17-38929	Anal. Chem., 35: 1673-5(1963)
19028	17-40279	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-060-45
19117	17-38682	Yale J. Biol. Med., 35: 504-22(1963)
19119	17-40079	Phys. Letters, 6: 98-9(1963)
19165	17-40080	Phys. Letters, 6: 108-11(1963)
19360	17-39025	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19406	17-39983	Dep.(mc); $4.60(fs), $1.64(mf) OTS
19410	17-38744	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19413	17-39453	Dep.(mc); $5.60(fs), $1.94(mf) OTS
19427	17-38745	Dep.(mc); $2.60(fs), $1.01(mf) OTS
19431	17-40163	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19432	17-38746	Dep.(mc); $3.60(fs), $1.22(mf) OTS

Report No.	Abstract No.	Availability
19436	17-39317	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19439	17-39108	Dep.(mc); $2.60(fs), $0.89(mf) OTS
19440	17-39109	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19446	17-39241	Dep.(mc); $15.50(fs), $7.37(mf) OTS
19451	17-39082	Dep.(mc); $3.60(fs), $1.28(mf) OTS
19458	17-40345	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19465	17-39542	Dep.(mc); $4.60(fs), $1.67(mf) OTS
19476	17-39221	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19482	17-39381	Dep.(mc); $13.00(fs), $5.66(mf) OTS
19483	17-39269	Dep.(mc); $14.00(fs), $6.41(mf) OTS
19485	17-39026	Dep.(mc); $5.60(fs), $2.00(mf) OTS
TM–	**(Misc.)**	
3770-67	17-39525	See AD-416459
TN–	**(Non-AEC)**	
84	17-39708	See ARL-62-459
313	17-40156	See ARL-63-182
TPR-RM–		
Vol.6, No.3	17-40313	Dep.; Reactor Materials. Volume 6, No. 3. August 1963. $0.55(GPO) (Domestic), $0.70(GPO) (Foreign)
TRG-Report–	**(Non-AEC)**	
357	17-39572	J. Nucl. Mater., 10: 1-7(1963)
540	17-39677	Dep.; $1.20(BIS); 6s. (HMSO)
616	17-39242	Dep.; $0.30(BIS); 1s. 6d. (HMSO)
UAC–		
5400	17-38979	See TID-14075
5414	17-38974	See TID-13734
6745	17-39564	See ANL-FGF-368
6746	17-39565	See ANL-FGF-369
6971	17-39892	See TID-17607
UCD–		
108	17-38632	Dep.; $2.75(OTS)
UCLA–		
517	17-39110	Dep.(mc); $2.60(fs), $0.92(mf) OTS
UCRL–		
2426(Vol.III) (1963 Ed.)	17-39846	Dep.; $2.25(OTS)
6811	17-40164	Dep.(mc); $3.60(fs), $1.16(mf) OTS
6901	17-40280	Dep.; $0.75(OTS)
6911(Pt.I)	17-39415	Dep.; $1.50(OTS)
7229	17-39984	Dep.(mc); $3.60(fs), $1.19(mf) OTS; Gmelin, AED-CONF-63-048-104 Phys. Rev., 132: 1123-30(1963)
7264	17-39725	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7328-T	17-38950	Mikrochim. Acta, No. 3, 561-6(1963)
7362-T	17-39027	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7393	17-39222	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7399-T	17-39223	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7424	17-40091	Phys. Letters, 6: 213-16(1963)
7427	17-39416	Dep.; $1.25(OTS)

Report No.	Abstract No.	Availability
10375	17-40101	Phys. Rev., 132: 723-8(1963)
10516	17-39981	Dep.(mc); $2.00(OTS)
10701	17-39543	Dep.; $2.25(OTS)
10707	17-40051	Nucl. Phys., 47: 184-206(1963)
10831	17-39399	Rev. Sci. Instr., 34: 1126-9(1963)
10853	17-40146	Dep.(mc); $2.60(fs), $0.98(mf) OTS
10886	17-39028	Dep.; $2.00(OTS)
10898	17-38706	Dep.; $2.75(OTS)
10918	17-39593	Phil. Mag. (8), 8: 1599(1963)
10953	17-39224	Dep.; $0.50(OTS)
11014	17-38886	Dep.(mc); $2.60(fs), $0.89(mf) OTS
11015	17-38887	Dep.(mc); $2.60(fs), $1.07(mf) OTS
11018	17-39847	Dep.(mc); $1.10(fs), $0.80(mf) OTS
13074	17-39270	Dep.; $2.50(OTS)
UCRL-Trans–		
989(L)	17-39726	Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS
990(L)	17-39031	Dep.(mc); $1.60(fs), $0.80(mf) JCL
UJV–	**(Czechoslovakian)**	
905/63	17-40281	Dep.(mc)
921/63	17-40282	Dep.(mc)
UR–		
610	17-38747	Dep.; $4.50(OTS)
631	17-38888	Dep.(mc); $1.10(fs), $0.80(mf) OTS
USCEC–	**(Non-AEC)**	
82-205	17-40165	$3.60(OTS)
USNRDL-TR–	**(Non-AEC)**	
633	17-39985	Dep.(mc); $4.60(fs), $1.43(mf) OTS
656	17-39318	OTS
657	17-39417	$2.60(OTS)
664	17-39418	OTS
666	17-38748	$1.60(OTS); Nature, 200: 46-8(1963)
667	17-40145	$3.60(OTS)
668	17-38749	OTS
WAPD-PWR–		
TE-149	17-40346	Dep.(mc); $1.10(fs), $0.80(mf) OTS
TE-153	17-40347	Dep.(mc); $1.10(fs), $0.80(mf) OTS
WAPD-T–		
1103(Rev.)	17-40305	Nucl. Sci. Eng., 17: 101-10(1963)
1440	17-39260	See CONF-129-17
1572	17-40306	Nucl. Sci. Eng., 17: 111-24(1963)
WAPD-TM–	**(Misc.)**	
312	17-40283	Dep.; $1.50(OTS)
313	17-39678	Dep.; $0.50(OTS)
390	17-40348	Dep.; $1.75(OTS)
WCAP–	**(Misc.)**	
2255	17-40349	Dep.(mc); $6.60(fs), $2.21(mf) OTS
WP–	**(Non-AEC)**	
22/6	17-38647	Dep.(mc)